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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 35059, 35980, and 36217.

Chemical Procedures

Refer also to abstracts 35053, 35060, 35491, 35492, and 35553.

34970 (AI-AEC-12799) DETERMINATION OF TRACE ELEMENTS IN SODIUM. Johnson, B. G.; Maseda, M. S. (Atomics International, Canoga Park, Calif.). June 15, 1969. Contract AT(04-3)-701. 30p. Dep. CFSTI.

Detailed analytical procedures for determination of trace elements (Bi, Fe, Cr, Mo, Ni, Nb, C, and O) in sodium are presented. The procedures are suitable for analysis of sodium samples containing as low as 2 μg of the metal or nonmetal sought. A number of analytical techniques, including spectrophotometry, flame spectrophotometry, atomic absorption, and gas chromatography, are utilized in the determinations. The analytical procedures for determination of the various solute materials are, in most cases, adaptations of published methods. The published procedures are adapted to accommodate the low levels of solute concentration and the interferences contributed by the collector materials. (auth)

34971 (CEA-R-3527) CONTRIBUTION TO THE STUDY AND TO THE DEVELOPMENT OF CONTINUOUS INFRARED ABSORPTION ANALYZERS. Coste, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 108p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

The continuous infrared absorption determination of corrosive gases implies the construction of an original single-beam spectrometer. The use of a vibration-rotation line means that the apparatus function has to undergo an alternating displacement: for one position this function is centered on the line, for an other position it is placed close by, but away from any absorption. A nonlinear relationship was derived between the concentration of the impurity under consideration, the optical density measured at the center of the line and the total pressure of the gas mixture. The problem was then solved using an associated specific analog computer. The system is applicable to the determination of low concentrations. The principle proposed was adapted for analysis of SiF_4, SF_6, UF_6, and HF using a non-resolved vibration-rotation band. (auth)

34972 (NLCO-1039) AUTOMATIC STEAM DISTILLATIONS OF FLUORIDE INTO SMALL VOLUMES. Bohlander, R. F. (National Lead Co. of Ohio, Cincinnati). Feb. 7, 1969. 17p. (CONF-690322-1). Dep. CFSTI.

From 20th Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Cleveland, Ohio.

A rapid method was developed to separate fluorides from interfering ions without excessive dilution. A controlled-temperature Willard-Winter type still was combined with a distillate recycler. Fluorides were trapped out of the distillate with thorium, after which the distillate was boiled and the steam reintroduced into the still. In this manner, the fluorides were removed from the samples in 20 minutes and isolated in a form requiring no further preparation prior to the color development. The apparatus developed for this distillation is relatively simple and inexpensive, and the fluorides are separated into less than 20 ml of distillate. Fluoride concentrations of less that 1 μg/ml can be determined accurately. Electric heating, controlled by a timer makes the operation automatic. Prior to the color development phase, an analyst is required only to add samples and reagents. (auth)

34973 (NLCO-1041) SIMULTANEOUS AUTOMATIC DETERMINATION OF URANIUM, ACID NORMALITY, IRON, AND AMMONIA IN PURIFIED URANYL NITRATE SOLUTIONS. Prall, J. R. (National Lead Co. of Ohio, Cincinnati). Apr. 8, 1969. Contract AT(30-1)-1156. 16p. (CONF-690611-1). Dep. CFSTI.

From International Congress on Automated Analysis, Chicago, Ill.

Procedures were developed for the automatic determination of uranium, acid normality, iron, and ammonia in purified uranyl nitrate solutions using a Technicon AutoAnalyzer. The method proved quite satisfactory for process control and could be easily modified for continuous, in-stream analysis. Analytical data are obtained within 5 minutes after the product is sampled. Uranium is determined by a direct colorimetric procedure. The uranyl nitrate solution is diluted with 1N HNO_3, and the absorbance is measured at 408 mμ. Acid normality is determined by mixing the sample with a solution of 350 g/l $(NH_4)_2SO_4$ and measuring the pH with a Beckman combination pH electrode. Acid concentration is then read from a standard graph. Iron is determined colorimetrically using 1,10-phenanthroline as the chromogenic reagent and sodium formate, formic acid as a buffer. The absorbance is measured at 520 mμ. Ammonia is determined by a method based on the blue idophenol color that forms when ammonia reacts with sodium phenate in the presence of sodium hypochlorite. The uranium present in the sample is complexed with sodium carbonate to prevent its precipitation. Sodium nitroprusside is added as a catalyst. The absorbence is measured at 607 mμ. (auth)

34974 (Y-1680) FLUOROMETRIC DETERMINATION OF COAL TAR OIL IN AIR SAMPLES. Chambles, A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 18, 1969. Contract W-7405-eng-26. 11p. Dep. CFSTI.

A fluorometric method was developed for determining microgram quantities of coal tar oil in air samples collected on mixed esters of cellulose filter pads and in toluene. The method is principally applicable to air contaminants originating from heated coal tar pitches, samples of which are collected in the immediate vicinity of workers in the environment. (auth)

34975 ULTRA-TRACE MASS SPECTROMETRIC METAL ANALYSIS USING HEPTAFLUORODIMETHYLOCTANEDIONE CHELATES. Kowalski, B. R. (Univ. of Washington, Seattle); Isenhour, T. L.; Sievers, R. E. Anal. Chem., 41: 998-1003 (July 1969).

A rapid, accurate ultra-trace mass spectrometric metal analysis using chelates of 1,1,1,2,2,3,3-heptafluoro-7,7-dimethyl-4,6-octanedione was developed. The analysis of fourteen metals (Al, Cr, Fe, Ni, Cu, Y, Pd, Nd, Sm, Dy, Ho, Tm, Yb, Pb) was accomplished using direct insertion to the ionizing source. Quantitative results were obtained on the order of 10^{-12} g of the metal and sensitivities as low as 10^{-14} g. The fragmentation patterns are generally simple allowing analysis of mixtures without preconcentration or chemical separation. Sample preparation and introduction are discussed and mass spectra of pure compounds and mixtures are presented. (auth)

34976 SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN SAMPLES OF MIXED OXIDES $(U-Pu)O_2$ BY DISTILLATION WITH A CARRIER IN AN ELECTRIC ARC. Arnal, T. (Commis-

sariat a l'Energie Atomique, Cadarache, France). Anal. Chim. Acta, 45: 333-6(Apr. 1969). (In French).

A comparative study was made of the two pure uranium and plutonium matrices in order to determine whether it were possible to choose experimental conditions that would facilitate the determination of impurities in a $(U-Pu)O_2$ matrix by interpolation between the pure uranium and plutonium calibration systems. The k factors obtained with the impurities Fe, Cu, Mn, Ni, Ag, B, Co, Mg, and Cr are tabulated. The comparison of theoretical and experimental results obtained shows that the k_e factor, which will give the impurity concentration in a mixed sample, can be determined from the pure uranium calibration. (J.S.R.)

34977 COMPLEX COMPOUNDS OF SCANDIUM WITH METHYLTHYMOL BLUE. Mal'kova, T. V.; Ovchinnikova, V. D.; Fateeva, N. A. Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 12: 391-7(1969). (In Russian).

The indicator Methylthymol Blue is recommended for complexometric and spectrophotometric determination of scandium ions. On the basis of spectrophotometric investigations of the system Sc^{3+}–Methylthymol Blue, complex compounds with molar ratios of 1:1 and 1:2 were found. Equilibrium constants for formation of the compounds were calculated. (M.C.G.)

34978 MICRODETERMINATION OF THORIUM(IV) USING 1(O-ARSENOPHENYLAZO 2-NAPHTHOL-3:6 DISULPHONATE (THORON) AS A CHROMOGENIC REAGENT. Sangal, Satendr P. (Univ. of Nagpur, India). Vijnana Parishad Anusandhan Patrika, 10: 127-9(July 1967). (In Hindi).

1-(o-Arsenophenylazo)-2-naphthol-3,6-disulfonate indexed as o-[(2-hydroxy-3,6-disulfonaphthyl)azo] benzenearsonic acid and trivially known as Thoron, was used as a chromogenic reagent in the determination of thorium. The range for adherence to Beer's law is between 0.63 and 34.2 ppM of thorium. The sensitivity of the reaction as defined by Sandell is 0.096 γ/cm^2 at pH 3.0. The absorption spectra of the 1:2 (Th(IV)-Thoron) chelate lies at 515 mμ. (auth)

34979 ON PROCESSES IN "ROTATING DISC" ELECTRODES AND THEIR INFLUENCE ON SPECTROCHEMICAL ANALYSIS IN SOLUTION. Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem., 245: 250-66(Apr. 29, 1969). (In German).

The reproducibility of the results of spectrochemical analysis in solution with "rotating discs" depends strongly on the uniformity of the absorption capacity of the electrodes and consequently on several physical properties of the graphite. The purpose of the research was to explain with the help of radioactive isotopes the processes taking place in the electrodes being made of different types of graphite, and the influence of these processes on the results of the spectral emission. Therefore, two series each of three electrode specimens made of three different types of graphite were investigated. The difference between the two series was that the three specimens of one series were thermally purified for a short time after their fabrication. A determination of the distribution of the radioactive isotopes in the rotating discs and a measurement of the intensity of the lines, showed that the types of purified electrodes are not so suitable for the spectral analysis in solution as the unheated ones. The activities and ΔY-data showed that also the rotating disc electrodes with low graphite density and consequently higher porosity are unsuitable for this type of solution analysis. It was established furthermore that the elements iron, cobalt, zirconium, and calcium show a different absorbing behavior. Variation in the depth of penetration of the four isotopes due to the chromatographical effect was obtained. It was concluded from these results that in the spectral analyses in solution not only the physical properties of the graphite as: density, porosity, grain size, electrical and thermal conductivity exert an influence but also the chemical properties. For a good reproducibility as well as a high detection sensitivity, rotating disc electrodes containing both small and large grains in their structure are recommended. (auth)

34980 EMISSION SPECTROMETRIC DETECTION OF THE ELEMENTS AT THE NANOGRAM PER MILLILITER LEVEL USING INDUCTION-COUPLED PLASMA EXCITATION. Dickinson, George W.; Fassel, Velmer A. (Ames Lab., Iowa). Anal. Chem., 41: 1021-4(July 1969).

Continuing investigations on the spectroscopic properties and analytical applications of induction-coupled plasmas have revealed that striking improvements in powers of detection of trace elements in solution may be realized through effective optimization of a number of experimental factors. The latter include: (a) desolvation of the nebulized solution before introduction of the sample into the plasma; (b) development of a plasma shape which allows more efficient introduction of the aerosol residue into the plasma; and (c) addition of a remote tuning facility for optimal coupling of the generator to the plasma. Emission detection limits of all elements investigated (including Ce, Ta, Th, U, Zr, and Hf) fall in the nanogram to fractional microgram per milliliter range. For many metals, the observed detection limits range from two to four orders of magnitude superior to the best values so far reported by flame atomic absorption or emission techniques. (auth)

34981 DIRECT SPECTROPHOTOMETRIC DETERMINATION OF SULFATE IN NATURAL WATERS BY FORMATION OF THE FERRIC SULFATE COMPLEX. Goguel, Reiner (DSIR, Petone, New Zealand). Anal. Chem., 41: 1034-8(July 1969).

A method is described that allows rapid determination of sulfate in the range of 10 to 500 mg/liter using the absorption of the $FeSO_4^+$ complex at optional wavelengths between 325 and 360 nm; it was applied to the analysis of geothermal waters from drillholes in New Zealand and of brines from the Antarctic ice shelf. The method is accurate for solutions with negligible concentrations of phosphate, fluoride, ferric ion, and other interfering ions. It can therefore be applied to most natural waters. For determinations in chloride brines the approximate concentrations of NaCl or other major components, which change the activities of the ions involved in the formation of the $FeSO_4^+$ complex, have to be known and corrections have to be made. A diagram for the estimation of such correction factors is given for alkali, magnesium, and calcium chloride brines. The simplicity of the analytical procedure makes the method particularly useful when sulfate has to be determined in a large number of water samples of similar composition. (auth)

34982 SOME OBSERVATIONS ON THE PHENYLFLUORONE METHOD FOR THE DETERMINATION OF TANTALUM. Bingham, Carleton D.; Maseda, Mary S.; Johnson, Betty G. (Atomics International, Canoga Park, Calif.). Anal. Chem., 41: 1144-7 (July 1969).

A study was made to ascertain the true reliability of the phenylfluorone method for the determination of Ta as a trace constituent (2 to 10 ppM) in lithium or potassium metal. In attempting to duplicate Hill's (Analyst 91, 659 (1966)) data with Ta solutions prepared from high-purity metal, statistical reproducibility in the 2 to 10 μg Ta range was demonstrated; however, slight differences existed between the absorbance observed. The precision of a Ta measurement in the 0 to 10 μg range in the presence of Mo and/or Li was determined. Results showed that the presence of Mo had no significant effects on the precision of the method; however, the presence of Li resulted in a significantly larger variance. (D.H.M.)

34983 SPECTROPHOTOMETRIC DETERMINATION OF TRIVALENT RUTHENIUM AND RHODIUM WITH THORON. Shrivastawa, Suresh C.; Munshi, Kailash N.; Dey, Arun K. (Univ. of Allahabad, India). Microchem. J., 14: 37-46(Mar. 1969).

Thoron is proposed as a sensitive and selective chelating reagent for the spectrophotometric determination of ruthenium(III) and rhodium(III). The mixture, metals and the reagent have to be maintained at boiling water temperature for 70 and 80 minutes, respectively, to give characteristic coloration. The molar ratio is 1:2 (metal:reagent) in both the chelates. The stability of the chelates, its composition, and analytical applications also were investigated and suggestions were made for the structure of the chelates. (auth)

34984 INFRARED ANALYSIS OF HEAVY WATER–WATER MIXTURES OF INTERMEDIATE (3 TO 97 PERCENT) CONCENTRATION. Kimbrough, Raymond D, Jr.; Askins, Robert W. (Georgia Inst. of Tech., Atlanta). Anal. Chem., 41: 1147-8 (July 1969).

A method is described for the isotopic analysis of water of intermediate (3 to 97%) heavy water concentration. The only equipment required is an infrared spectrometer of customary range with the standard salt cells. The accuracy of the method is affected little by impurities, much less than in other methods. Both the mole % hydrogen and the mole % deuterium are determined directly from one spectrum; hence no calibration curve need be constructed. (D.H.M.)

34985 SPECTROPHOTOMETRIC DETERMINATION OF HAFNIUM AS REDUCED MOLYBDOSULFATOHAFNIC ACID. Clowers, C. C. Jr.; Guyon, J. C. (Univ. of Missouri, Columbia). Anal. Chem., 41: 1140-2(July 1969).

A study was made to furnish qualitative existence of a simple heteropolymolydohafnic acid or a related species, and to develop a quantitative spectrophotometric method for the determination of Hf based on some mechanism of formation of its heteropolymolybdate. Chlorostannous acid was selected as the reductant. The system obeyed Beer's law over the approximate range of 8 to 50 ppM of Hf. The effects of 26 ions including Th^{4+} and Zr^{4+}

were studied. Evidence was presented for interaction between Hf(IV) and isopolymolybdate, the resulting species was probably of the normal 12:1 type, (for example $HfO(Mo_3O_{10})_4^{7-}$). It was shown, however, that this resulting species was not reducible to a blue hue unless sulfate was present. (D.H.M.)

34986 HIGH FREQUENCY EXCITATION OF INDEPENDENTLY VAPORIZED SAMPLES IN EMISSION SPECTROMETRY. Kleinmann, Imrich; Svoboda, Vratislav (Inst. for Research, Production, and Use of Radioisotopes, Prague). Anal. Chem., 41: 1029-33(July 1969).

The construction of the discharge chamber is described. The sample is evaporated from a graphite disk, which is heated by ohmic current. The vaporized sample is excited in an electrodeless discharge (40 MHz, 200 W), burning above the disk in argon at atmospheric pressure. The influence of various parameters was investigated. The limits of detection are compared with those published for the high current argon arc. The limits of detection might be substantially improved using a more appropriate monochromator and detection system. (auth)

34987 KINETIC DETERMINATION OF MOLYBDENUM USING A POTENTIOSTAT. Weisz, H.; Klockow, D.; Ludwig, H. (Univ., Freiburg i. B.). Talanta 16: 921-8(July 1969). (In German).

A kinetic method is described for the determination of molybdenum by its catalytic effect on the peroxide–iodide reaction. The reaction rate is kept constant by adding iodide at the same rate as it is consumed, the concentration being kept constant by a potentiostat. The rate of the addition of iodide is then proportional to the molybdenum concentration. The element was determined in the range 0.5 to 11 μg in 50 ml. (auth) (UK)

34988 EXTRACTION-PHOTOMETRIC STUDY OF THE REACTIONS OF CERIUM SUBGROUP RARE EARTHS WITH ARSENAZO III AND DIPHENYLGUANIDINE. Akhmedli, M. K.; Melikov, A. A. Azerb. Khim. Zh., No. 5, 104-9(1968). (In Russian).

It was established that cerium subgroup rare earths form complex compounds with Arsenazo III and diphenylguanidine. The compounds have increased optical density and are extracted with butyl and isobutyl alcohols. The relation of the optical density of the compounds to pH was studied. Optimum pH for Pr^{3+}, Nd^{3+}, Sm^{3+}, and Gd^{3+} was 6, and for La^{3+} it was 7. The distribution coefficients were determined along with the percent extraction of the rare earths. An extraction-photometric method for determination of the cerium subgroup rare earths was developed and applied to the analysis of monazites. (M.C.G.)

34989 SEPARATION AND SOLVENT EXTRACTION OF VANADIUM AND URANIUM WITH n-PROPYL 2,3,4-TRIHYDROXYBENZOATE. Jasim, F. (Univ. of Baghdad). Talanta, 16: 752-6(June 1969).

A spectrophotometric method is described for the separation and determination of trace quantities of vanadium(IV) and (V) from uranium(VI). Vanadium is selectively separated from uranium by extraction at pH 6.5 into n-propyl 2,3,4-trihydroxybenzoate (PTB) dissolved in t-pentanol. Up to 120 μg of vanadium can be determined by measuring the absorbance of the blue complex in the organic phase at 585 nm. Uranium(VI) remains in the aqueous layer and can be determined spectrophotometrically by its reaction with PTB in aqueous acetone to produce a brown-red color at pH 7.6 to 8.8. Solutions containing 25 to 275 μg of uranium absorb at 370 to 380 nm according to Beer's law. By modification this procedure can be used for the determination of the two elements in native phosphate rocks. The effects of diverse ions on the determination of vanadium and uranium were examined. (auth) (UK)

34990 PRELIMINARY INVESTIGATIONS ON THE MEASUREMENT OF PRIMORDIAL AND COSMOGENIC RADIONUCLIDES IN LUNAR SURFACE MATERIALS. Perkins, R. W.; Rancitelli, L. A.; Wogman, N. A.; Cooper, J. A.; Kaye, J. H. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 45-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

34991 SAMPLING AND ANALYZING FEEDWATER. Sawochka, S. G.; Pearl, W. L. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 12: 71-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

34992 SOME CURRENT ANALYTICAL PROBLEMS IN NUCLEAR ENERGY. Baetsle, L. H.; Lievens, F.; Demildt, A. C.; Lecocq, A.; Monsecour, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Ind. Chim. Belg., 33: Spec. Issue, 165-72 (1969). (In French).

In the field of fuel production, emphasis has been put on production of pure U or on detection of impurities having a specific neutron effect (for example, B). Radiochemical analysis of fission products, Pu isotopes, and newer elements determines combustion yields; new methods developed at Mol for ^{137}Cs, ^{90}Sr, ^{148}Nd, and ^{100}Mo are noted. The analysis of U and Pu isotopic compositions by the radiochemical method is not precise but is more economical than mass spectrometric analyses. After radiochemical characterization of fuels left in the reactor, the fissile and fertile elements are recovered. A fluorination process serves as the basis at Mol; chemical analysis was used to determine the most favorable conditions. While U analysis may be done by polarography, potentiometry, or coulometry, the valence states of Pu necessary are unstable and certain elements interfere, requiring prior separation. (BBB)

34993 APPLICATIONS OF RADIOISOTOPE X-RAY FLUORESCENCE ANALYSIS IN GEOLOGICAL ASSAY, MINING, AND MINERAL PROCESSING. Clayton, C. G. (Atomic Energy Research Establishment, Wantage, Eng.). pp 293-324 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Techniques and applications of radioisotope x-ray fluorescence in mining and mineral processing are reviewed. The advantages and limitations are discussed, and an indication is given of the direction in which further advances may be expected. (auth)

34994 RADIOISOTOPIC X-RAY ANALYTICAL TECHNIQUES FOR GOLD AND SILVER ORES. Burkhalter, P. G. (Bureau of Mines Metallurgy Research Center, College Park, Md.). pp 365-79 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The sensitivity of radioisotopic, energy dispersion x-ray techniques using semiconductor detectors for silver and gold ores was studied. The sensitivity of semi-portable silicon and germanium (Li-drifted) semiconductor detectors for silver was measured under optimum laboratory conditions with a 3 mm × 80 mm^2 Si semiconductor with a FWHM pulse resolution of 1.22 keV for Ag Kα. Source-target assemblies for producing monoenergetic x-rays of Sb, I, and Cs, and an annular source of ^{125}I which emits Te x-rays were used for exciting silver. The peak-to-background ratios measured at the 1000 ppM silver concentration were 1.4, 2.6, 3.0, and 2.1 for Sb, Te, I, and Cs radiation, respectively, using FWHM electronic discrimination. The peak-to-background ratio versus different levels of electronic discrimination was compared for the various monoenergetic sources. For the annular ^{125}I source (2.0 mCi strength) a detection limit of 21 ppM in 100-sec counting intervals was obtained for a pure silica matrix. With optimum source strength, a normalized detection limit of 4.5 to 6 ppM was calculated for the four monoenergetic x-ray sources in 180-sec counting intervals. A 5 mm × 80 mm^2 Ge semiconductor detector was installed for work involving the higher energy Au K spectra. Because of a high background from multiple scatter, a peak-to-background ratio of only 0.23 was obtained. A normalized detection limit of 20 ppM for gold is possible in 100-sec counting intervals. (J.G.B.)

34995 MEASUREMENT OF LEAD ISOTOPES BY DIFFERENTIAL ATOMIC ABSORPTION. Brimhall, Willis H. (Brigham Young Univ., Provo, Utah). Anal. Chem., 41: 1349-51(Aug. 1969).

Previous experiments on differential atomic absorption of Pb indicated that sufficient differences exist in the hyperfine spectrum of Pb, attributable to isotopes, to form the basis of a technique for measurement of Pb isotopes. The instrument used is an atomic absorption spectrophotometer equipped with a strip chart recorder and three hollow cathode source lamps prepared from Pb enriched in ^{206}Pb, ^{207}Pb, and ^{208}Pb. A set of simultaneous linear equations was formulated to solve for the concentrations of Pb isotopes in an unknown. (M.C.G.)

34996 SELECTIVE METHOD FOR THE DETERMINATION OF THE TOTAL RARE EARTH ELEMENTS AND THORIUM IN MINERAL MATERIAL. Galkina, L. L.; Sosnovs'kaya, E. Yu. (Central Asian Scientific-Research Inst. of Geology and Mineral Raw Materials, Tashkent). Zh. Anal. Khim., 24: 938-41(June 1969). (In Russian).

A method was developed for the gravimetric, complexonometric, or photometric (with Arsenazo III) determination of the rare earths and thorium (more than $n \cdot 10^{-3}$%). The rare earths and thorium are separated by means of extraction with butyric acid. The method was applied to the determination of the rare earths and

thorium in mineral raw material and complex artificial mixtures of elements. The results obtained are satisfactory. (auth)

34997 PHOTOCHEMICAL REACTIONS IN ANALYTICAL CHEMISTRY. COMMUNICATION 7. DETERMINATION OF URANIUM BY MEANS OF THE PHOTOCHEMICAL REDUCTION OF METHYLENE BLUE SOLUTIONS. Nemodruk, A. A.; Bezrogova, E. V. Zh. Anal. Khim., 24: 859-64(June 1969). (In Russian).

A study was made of the reduction of methylene blue on its irradiation with ultraviolet light in the presence of uranium and ethanol. Methylene blue is reduced to a leuko compound by uranium(IV) which is formed on the photochemical reduction of uranium(VI) by ethanol. The decrease of the optical density of methylene blue solutions is a linear function of the uranium concentration. A method is suggested for the determination of small amounts of uranium. (auth)

34998 DETERMINATION OF MICROQUANTITIES OF THORIUM IN PREPARATIONS OF THE RARE EARTH ELEMENTS. Antonov, A. V.; Shtenke, A. A.; Shvarev, V. S. Zh. Anal. Khim., 24: 848-52(June 1969). (In Russian).

A study was made of the synergistic effect during the thorium extraction from hydrochloric and nitric acid solutions with a mixture of tributyl phosphate (TBP) and di-(2-ethylhexyl) phosphate (D2EHPA) in toluene, benzene, hexane, cyclohexane, and carbon tetrachloride. It was found that at the acidity of 0.025 to 0.1 N the extraction increases with the increase of the D2EHPA amount in the mixture. The maximum extraction is achieved at a molar ratio of D2EHPA: TBP within 0.06 to 0.085 depending on the nature of the solvent. A method was developed for determining thorium in rare earth oxides, their mixtures and concentrates. The method includes thorium extraction from a 0.1 N solution of hydrochloric acid with a mixture of TBP and D2EHPA in carbon tetrachloride, its back extraction with a 4 N hydrochloric acid solution and its photometric determination in the stripping solution with Arsenazo III. The interference of Fe^{3+} and Ce^{4+} is eliminated by reducing them to lower valency states; F^- and PO_4^{3-} are complexed with Al^{3+}. (auth)

Isotopic Procedures

34999 MEASUREMENT OF ATMOSPHERIC RADON GAS AND ITS DECAY PRODUCTS CONCENTRATIONS BY GAMMA-RAY SPECTROMETRY. Megumi, Kazuko; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect., 9: 14-17(1968).

A method of determination of atmospheric Rn, RaB, RaC, and ThB concentrations by gamma-ray spectrometry is described. Radon concentration is determined by gamma-ray spectrometry of a radon sample collected in an activated charcoal trap kept at dry-ice temperature. Concentrations of RaB, RaC, and ThB are determined by gamma-ray spectrometry of a dust sample collected on a glass wool filter. The diurnal variation of concentrations of these nuclides was observed using this method and it was confirmed that the method is conveniently used for simultaneous determination of concentrations of these radionuclides in the atmosphere. (auth)

35000 ISOTOPE DILUTION ANALYSIS IN THE MICRO AND SUBMICRO-RANGE BY DOUBLE-LABELLING AND PRECIPITATION ON PAPER. Weisz, H.; Krivan, V. (Univ., Freiburg i. B.). Talanta, 16: 823-6(July 1969).

A new variation of isotope dilution analysis, based on double labeling and carried out on filter paper, is described. The determinations of microgram and submicrogram amounts of silver (labeled with ^{110m}Ag) by precipitation with iodide (labeled with ^{131}I) and of calcium (labeled with ^{45}Ca) by precipitation with phosphate (labeled with ^{32}P) are given as examples. In the first example the two radioelements (^{110m}Ag and ^{131}I) are measured by γ-spectrometry; in the second ^{45}Ca and ^{32}P by a β-absorption method. A number of results show the usefulness of the method. (auth) (UK)

35001 RADIOACTIVE KRYPTONATES IN VOLUMETRIC ANALYSES. Tolgyessy, Juraj (Univ. of Bratislava). Chem. Listy, 63: 513-37(May 1969). (In Czech).

Radioactive indication of the end-point of titration has been studied previously by the author, et al. The method originated by D. J. Chleck (Radiochemical Methods of Analyses, p. 273, (1965)) concerning the use of radioactive kryptonates was further developed. These materials include the ^{85}Kr nuclide in the system. The end-point determination is based on the selective reaction of the nonradioactive component with the kryptonate, during which ^{85}Kr is released at the surface. The kryptonate indicators include $Mg[^{85}Kr]$, $Zn[^{85}Kr]$, $AgIO_3[^{85}Kr]$, $Y_2(2O_4)_3 \cdot [^{85}Kr]$ and $Ag[^{85}Kr]$; the reactions on which the titration is based cover neutralization, chelatometry, complexometry, etc. (TTT)

Radiometric Procedures

Refer also to abstracts 35392, 35488, 35490–35492, 35505, 35511–35513, and 35604.

35002 (NP-17919) SAMPLE PREPARATION FOR LIQUID SCINTILLATION COUNTING. Turner, J. C. (Amersham/Searle Corp., Des Plaines, Ill.). [1967]. 30p. Dep.

A selective literature review of methods for sample preparation is given. Some of the more theoretical aspects of liquid scintillation counting are discussed. Topics covered include: liquid scintillation solvents and solutes, counting in solution, counting suspensions, counting paper and thin-layer chromatograms and samples dried on paper or glass fiber, counting emulsions, counting gases and vapors, counting flowing aqueous solutions, determination of counting efficiency, and sources of error. (M.C.G.)

35003 METHOD FOR EXAMINATION OF SAMPLES OF NUCLEAR FUEL OR WHOLE NUCLEAR FUEL ELEMENTS WITHOUT DESTRUCTION THEREOF. (to Oesterreichische Studiengesellschaft fuer Atomenergie GmbH). French Patent 1,453,143. Filed Nov. 9, 1965.

A method was developed for determining the amounts of a component in a sample whereby the transmissions of the sample for different neutron energies are established and compared with one another. Preferably a range of neutron energies is used for which the component has a resonant absorption. As a further range of neutron energies the range of energies of thermal neutrons may be utilized. The range of the neutron energies used may be adjusted by establishment of the flight-time of the neutrons between a source and a detector of a device for carrying out the method. Several ways for effecting the method are described; the devices used are shown. (NPO)

35004 DETECTION, IDENTIFICATION, AND ANALYSIS OF FISSIONABLE ISOTOPES. Keepin, G. Robert (to United States Atomic Energy Commission). U. S. Patent 3,456,113. July 15, 1969.

A method and apparatus are described for detection, identification, and quantitative analysis of the individual isotopes in unknown mixtures of fissionable materials. The unknown mixture is irradiated with a neutron source and the kinetic behavior of the delayed neutron activity is detected and analyzed to provide isotopic assay. The invention has special utility in the areas of nuclear inspection, safeguard, and control. (AEC)

35005 NEW TYPE OF RADIOMETRIC ANALYSIS: NON-EQUILIBRIUM ISOTOPIC EXCHANGE METHOD. Ikeda, Nagao; Kimura, Kan; Takahashi, Yasuko; Fujiki, Yoshiko (Tokyo Kyoiku Univ.). Radioisotopes (Tokyo), 18: 224-6(June 1969).

A method of radiometric analysis based on an isotope exchange system in which the exchange rate is rather slow is described. The validity of the principle was verified experimentally with the homogeneous system n-C_4H_9I–KI in 90% acetone. ^{131}I was used to measure the isotopic exchange rates, and it was found that 0.1 mg of iodine can be determined in butyl iodide with a ±4% error. (M.C.G.)

35006 RAPID METHOD FOR ESTIMATING RADIUM AND RADON IN WATER. Kelkar, D. N.; Joshi, P. V. (Bhabha Atomic Research Centre, Trombay, India). Health Phys., 17: 253-7(Aug. 1969).

A rapid method for the estimation of radium and radon in water samples with activity levels more than 1 to 2 pCi/l is described. Radium and daughter products of radon are precipitated with more than 95% efficiency in the presence of ZnS (Ag) scintillation powder giving a composite scintillator-sample combination. Apart from being rapid and inexpensive, the method is suitable for field use as it requires very little apparatus and does not involve laborious chemical analysis. Effects of temperature, pH, and amount of ZnS (Ag) were studied and conditions for optimum yield were determined. Results of radium and radon levels in some thermal springs measured in the field using this method are presented. (auth) (UK)

35007 ANALYSIS OF NUCLEAR FUEL BY GAMMA SCANNING. Christensen, D. E. (Battelle-Northwest, Richland, Wash.); Murphy, E. S. Trans. Amer. Nucl. Soc., 12: 93-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35008 MULTI-SPECTRA IRRADIATION TECHNIQUE FOR THE NONDESTRUCTIVE ASSAY OF FISSIONABLE MATERIALS. Auguston, R. H.; Masters, C. F.; Menlove, H. O. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 94-5 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35009 TWO-DIMENSIONAL GAMMA SCANS OF THIN FUEL-ELEMENT SECTIONS. Barnes, Barry K.; Holm, Dale M.; Sanders, W. Mort; Swansen, James E.; Clinton, David D. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 95-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35010 RAPID DETERMINATION OF ^{90}Sr IN BIOLOGICAL MATERIALS VIA SOLVENT EXTRACTION OF ^{90}Y. Ijuin, Muneaki; Nakamura, Ryoichi; Tanaka, Giichiro (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 18: 268-70(July 1969).

A method is described for the determination of ^{90}Sr in cow's bone, milk, and egg. Dibutyl phosphate is used for the elimination of contaminants from the yttrium fraction. In this method, Zr and Yt are extracted in the organic phase. While the latter is back-extracted with concentrated HCl or HNO_3, the former is not. Although U and Th are extracted by a few percent in the extraction, they are almost negligible in the radioactivity of the counting sample. The chemical yield and the facility of this extraction method were compared with those of the fuming nitric acid method. (P.C.H.)

35011 UEBERWACHUNG DER RADIOAKTIVITAET IN ABWASSER UND ABLUFT. HEFT 2. (Control of the Radioactivity in Waste Water and Exhaust Air. Number 2). Kiefer, H.; Maushart, R. Stuttgart, Verlag B. G. Teubener, 1967. 120p.

Existing methods and equipment for the control and determination of radioactivity in air and water are reviewed. A detailed account of the methods which have proved most successful and reliable is given. A survey is given of the basic medical and biological standards which are required to establish the permissible concentrations for radioactivity in air and water, taking into consideration the most recent advances in science and technology. (auth)

35012 DETERMINATION OF URANIUM IN SOLUTION BY MEASURING INTERNAL CONVERSION X RAYS. Bourseau, R.; Fabre, P.; Zini, E. (CEA, Fontenay-aux-Roses, France). pp 249-54 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969. (In French).

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The measurement of internal conversion x-rays of uranium was used for determining the uranium content of solutions. This was done by titrating from as little as 10 mg of uranium per litre, the volume of sample required being 20 ml and the measurement time about 10 min. The equipment used was of the standard type: a thin-crystal scintillation detector and a single-channel collector with a scaler. Certain daughter elements of uranium emit x-rays in the same energy band. Simple procedures were developed for eliminating them in both acid and alkaline solutions so as to obviate errors due to disruptions of radioactive equilibrium. The method can be used for the determination of natural as well as industrial solutions and is applicable to the content of all solutions actually encountered in operations, from drainage waters to factory processing waste. (auth)

35013 METHODS AND MATERIALS FOR THE INVESTIGATION OF THE CONTAMINATION OF THE HYDROBIOSPHERE BY ^{90}Sr. Sokolova, I. A.; Parchevskii, V. P.; Sokolova, I. V. Okeanologiya, 8: 1092(1968). (In Russian).

Radioactive contamination of the seas and oceans by fallout necessitates widespread investigations of the artificial radioactive materials produced, particularly those creating the greatest biological danger; thus a study of the precision of analytical methods for ^{90}Sr was made. Emphasis was made on techniques of precipitation of ^{90}Sr from aquatic organisms and water, radiometric analysis, and analysis of ^{90}Y fallout. Calculations of ^{90}Sr concentrations were made in connection with the ^{90}Y analysis. Data on the ^{90}Sr content in green, brown, and red algae, flowering plants, corals, molluscs, crabs, fish, and mammals from the northwest part of the Indian Ocean, the south Atlantic, the Red Sea, and other bodies of water are presented for the years 1965 to 1967. (BBB)

35014 DETERMINATION OF ORE CONCENTRATION IN EXPLORATION HOLES BY THE GAMMA-RAY BACKSCATTERING TECHNIQUE. Donhoffer, D. K. (Atomic Energy of Canada Ltd., Ottawa). pp 23-35 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The gamma backscattering technique was applied to the determination of zinc concentration in exploration holes in a zinc–lead mine. The special geological situation allowed the calculation of calibration curves for different sources and source detector geometries. ^{60}Co, ^{137}Cs, and ^{75}Se were used as gamma sources. The best results were obtained using ^{137}Cs. Different probe lengths were investigated, and the optimal configuration was determined in test measurements in the mine. Measurements were carried out with the optimized probe in drill holes, for which the zinc concentration had already been determined by core sampling techniques and chemical analyses. The measurements from the backscattering techniques were evaluated by calculated calibration curves. Very good agreement of the results was obtained in comparison with the chemical drill analyses. The mean deviation for a typical borehole of 50 m length was 1%. The backscatter probe was used in connection with a portable ratemeter. The time constant used was 15 sec. The statistical accuracy of the count-rate measurement was better than 0.5%. The speed of the measurements was about 25 m/h. The total length of investigated boreholes was 940 m. (auth)

35015 SELECTIVE NATURAL GAMMA LOGGING. Czubek, J. A. (Institut de Recherches Nucleaires, Krakow); Dumesnil, P. pp 223-48 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969. (In French).

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Natural gamma logging was used for determining the bismuth-214 (or RaC) content of uranium-bearing rocks. As the equilibrium coefficient of ores cannot be satisfactorily measured in situ, the log obtained cannot be used to determine uranium content directly. The principle of the new technique of selective natural gamma logging is the use of the photoelectric effect due to the presence of uranium in rock. Natural gamma radiations are emitted but then scattered by the ore. The presence of uranium causes a change in the shape of the scattered gamma spectrum and this change can be related to the uranium content. If the similitude principle is applied to the transport equation for gamma radiation, the numerical value of a certain parameter P, representing the ratio of the number of counts obtained in two bands I_1 and I_2 of the scattered gamma spectrum, depends on the value of the equivalent atomic number of the rock (Z_{eq}). For any given deposit the value of the parameter varies mainly with the uranium content q_u and very little with the chemical composition of the matrix. The first laboratory tests were carried out on concrete models of uranium ore. Examination of spectra obtained (using a 400-channel selector) showed that the two boundaries I_1 and I_2 should range between 100 and 150 keV and 300 and 700 keV, respectively. A field survey rig mounted on a lorry was developed. It comprises a NaI(Tl) scintillator probe and, at the surface, two single-channel selectors used for definition of bands I_1 and I_2, and a spectrum stabilizer. Two scalers and two linear count-rate meters coupled to a two-channel potentiometric recorder were used for obtaining the counting rates for I_1 and I_2 at a fixed point, together with the log corresponding to these quantities. This surface electronic equipment was made up of standard "Renatran" elements. The aggregate was mounted on a laboratory lorry with all necessary equipment for prospecting work. The first tests were carried out at Lodève (France) and bore out the validity of the new method. The increase in the ratio $P = I_2/I_1$ as a function of content is indicated by the intersection of the curves I_1 and I_2 whenever a significant radioactive anomaly is traversed. A precise quantitative interpretation of these results will require the development of a new calculation method. (auth)

35016 FIELD DETERMINATION OF IRON USING X-RAY FLUORESCENCE AND GAMMA-RAY SCATTERING. Dziunikowski, B.; Niewodniczanski, J. (Inst. of Nuclear Techniques, Krakow). pp 343-51 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The concentration of the element of interest in strip mining is sometimes controlled by shallow pilot boreholes, particularly in the case of an irregular deposit. It is desirable that the cores should be analyzed directly in the field rather than in the laboratory. Two radiometric methods for such a determination of iron in ore are described: radioisotope x-ray fluorescence and the scattering of gamma-rays with energy less than 100 keV. (auth)

35017 ALPHA-RADIOACTIVITY ON SURFACE OF SEVERAL STRUCTURAL MATERIALS. Barabanov, I. R.; Veshnikov, V. B.; Pomanskii, A. A. At. Energ. (USSR), 26: 299-300(Mar. 1969). (In Russian).

Alpha activity on the surface of brass, steel, Dural, copper, and

stainless steel was determined by measuring α particles using a 30 × 30 × 160-mm proportional counter with a 20-μ-diameter tungsten filament anode. Pulses exceeding 1 MeV were recorded. Data show the content of U and Th in a gram of material calculated with the assumption that the ^{232}U and ^{228}Th are in equilibrium with their fission products and that there are three times more ^{232}Th than ^{232}U. Results of the measurements revealed a smaller content of uranium and thorium in the materials examined than was previously indicated in published data. (R.V.J.)

35018 ATOMIC-ABSORPTION ANALYSIS OF RADIOACTIVE PREPARATIONS OF ZINC AND CADMIUM. L'vov, B. V.; Khartsyzov, A. D. (State Inst. of Applied Chemistry, Leningrad). Zh. Anal. Khim., 24: 936-8(June 1969). (In Russian).

Radioactive ^{109}Cd and ^{65}Zn sometimes contain stable isotopes when the initial cyclotron targets and reagents used for the separation of radioactive isotopes are insufficiently pure. The "carrier" content was estimated by comparing the total amount of the element measured by the atomic absorption method with the isotope content calculated by measuring the activity. A simple device permits the reliable isolation of the analytical space. The method is highly sensitive and safe. (auth)

35019 CHEMICAL SEPARATION OF CERIUM FISSION PRODUCTS FROM MICROGRAM QUANTITIES OF URANIUM. Albu-Yaron, Ana; Mueller, D. W.; Suttle, A. D. Jr. (Texas A and M Univ., College Station). Anal. Chem., 41: 1351-3(Aug. 1969).

A method was developed for the separation of cerium, which may be used subsequently to determine nanogram quantities of uranium in raw cores. It involves the fission of uranium, separation of an abundant fission product such as cerium, and counting the activity of the cerium. On an anion exchange column in the Cl^- form equilibrated with concentrated HCl, cerium is quantitatively separated from all anions and cations of oxidation state IV, V, and VI. From the effluent containing alkaline earths, rare earths, and alkali metals, cerium is isolated as $Ce(IO_3)_4$, mounted, and counted. Recovery is greater than 95%; usually 99% can be obtained. Possible interferences and sources of error are discussed. (M.C.G.)

35020 DETERMINATION OF ^{40}K BY GAMMA RAY SPECTROMETRY FOR ^{40}K-^{40}Ar GEOCHRONOLOGY. Civetta, Lucia (Univ., Naples); Gasparini, Paolo; Adams, John A. S. Anal. Chem., 41: 1319-22(Aug. 1969).

Routine determinations of ^{40}K can be made by using gamma spectrometric instruments normally used in the analysis of radioactivity in common rocks. Potassium salts of different densities and average atomic numbers were investigated in order to determine the influence of density, atomic number, and sample size on the counting rate recorded within the full energy peak. No variation greater than the errors was observed between different salts measured in the same size container. Potassium contents in four minerals and one whole rock sample were measured. (M.C.G.)

35021 MEASUREMENT OF β-EMITTING NUCLIDES USING CHERENKOV RADIATION. Ross, H. H. (Oak Ridge National Lab., Tenn.). Anal. Chem., 41: 1260-5(Aug. 1969).

The variables that determine the Cherenkov counting response of small liquid systems are presented. A control of these variables will permit the optimization of Cherenkov measurements with any conventional liquid scintillation counter. The design of a counter specifically for Cherenkov emission is also suggested. A new calculation of the photon yield of electrons passing through water indicates the requirements of the electronic counting system. (auth)

35022 THE DETERMINATION OF PLUTONIUM ALPHA ACTIVITY IN HUMAN URINE BY SOLVENT EXTRACTION. Kataoka, Keiichi; Inouye, Takeichiro (Musashi Inst. of Tech., Kawasaki, Japan). Hoken Butsuri, 4: No. 1, 38-41(Mar. 1969). (In Japanese).

For analysis of human urine for Pu, the urine sample is wet-ashed with HNO_3 and the residue dissolved in HCl. Plutonium (IV) is coprecipitated with iron cupferride from this solution and extracted with chloroform. After removal of the iron by liquid extraction, the Pu is electrodeposited onto a stainless steel disc with a circular area of deposition of 254 mm^2 from an electrolyte 1M in NH_4Cl and 0.01M in oxalic acid and α counted. The quantitative electrodeposition of Pu and removal of the Fe by extraction with di-isopropyl ether is discussed. The recovery of 1 to 100 dpM of Pu from 1.5 l of urine is 80.7 ± 9% and the analysis time 4 to 5 hr. (NSA of Japan)

35023 ^{131}I CONCENTRATIONS IN AUSTRALIAN MILK RESULTING FROM THE 1968 FRENCH NUCLEAR WEAPON TESTS IN POLYNESIA. Bonnyman, J.; Duggleby, J. C. (Commonwealth X-Ray and Radium Lab., Melbourne). Aust. J. Sci., 31: 389-92(May 1969).

Detailed results are given of ^{131}I assays of milk from eight production areas in Australia following the 1968 French nuclear tests in the South Pacific. The sampling that commenced on July 13 and finished on November 17 monitored directly the milk consumption of 60 percent of the population. ^{131}I was precipitated as protein using the trichloroacetic acid method and counted in a NaI(Tl) well crystal. The simpler and faster ion exchange method was tested and found to have a small positive bias due to ^{131}I remaining on the resin after regeneration. Except for a station with latitude close to that of the test site, the integrated concentration at each center lay between that of the 1966 and 1967 tests. The longer settling time of fallout from high yield tests led to ^{131}I constituting a smaller percentage of the total fallout from such tests. The National Radiation Advisory Committee's dose limit for the average young child is 200 picocuries/liter, averaged over 12 months. Even where milk was consumed immediately after production, the dose to thyroids of young children in the sampled areas would have been very much less than this limit. ^{131}I in dried or evaporated milk would have decayed between manufacture and consumption. (Australia)

Activation Procedures

Refer also to abstracts 35327, 35493, and 35583.

35024 (CEA-R-3694) CONTRIBUTION TO ACTIVATION ANALYSIS WITH 14-MeV NEUTRONS IN THE CASE OF RADIOELEMENTS HAVING A HALF-LIFE LESS THAN ONE SECOND. Golanski, Andrzej (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1969. 115p. (In French). Dep.

The particular problems arising from the use in the activation analysis of radioelements having a half-life of less than one second were studied in the case where no sample transfer occurs. Fifteen nuclear reactions were studied in order to obtain information about the possibility of using them in activation analysis using pulses of 14-MeV neutrons. The half-lives of the radioisotopes produced vary from 0.5 to 870 milliseconds. The results obtained using low flux neutron generator are discussed mainly from the point of view of sensitivity and accuracy. (auth)

35025 (NBS-TN-458) ACTIVATION ANALYSIS SECTION. Summary of Activities, July 1967-June 1968. LaFleur, Philip D. (ed.) (National Bureau of Standards, Boulder, Colo. Inst. for Materials Research). Mar. 1969. 96p. GPO $1.00.

The facilities used by the reactor, LINAC, and neutron generator groups for activation analysis are described. Proposed installation of four new irradiation terminals and a new pneumatic transfer tube system are outlined. A 2.5-mA neutron generator was installed and the biological shield, pneumatic transfer system, and the detector assembly modified. Studies of blank problems for oxygen determination and self-absorption corrections in photopeak analysis resulted in greatly improved precision for Standard Reference Materials. Halides in photographic emulsions, using 14- and 2.6-MeV neutrons, were determined. Considerable emphasis was placed on the development of group radiochemical separations; SRM steel and high-purity zinc samples were analyzed using this technique. Eighteen different SRMs were analyzed for a variety of elements and a variety of service analyses were performed. The self-absorption effects of the matrix on irradiation photons were studied and calculations of sensitivities for photon activation analysis were made. Carbon in sulfur, yttrium in rare earth oxides, and oxygen in sodium were determined by photon activation. The extraction of metals by bis(2-ethylhexyl) orthophosphoric acid was studied, and distribution coefficients are given for many of the transition metals. The results indicate enhanced applicability of this reagent for radiochemical separations. (auth)

35026 DETERMINATION OF SAMARIUM AND GADOLINIUM IN RARE EARTH ORES BY NEUTRON CAPTURE GAMMA-RAY ACTIVATION ANALYSIS. Lombard, S. M.; Isenhour, T. L. (Univ. of Washington, Seattle). Anal. Chem., 41: 1113-16(July 1969).

The nondestructive neutron capture gamma-ray activation analysis of four of the most common ores of the rare earths for samarium and gadolinium is described. A large coaxial Ge(Li) detector provides adequate resolution of the capture gamma-ray spectra and a high speed chopper permits automatic background subtraction. Data from 10-minute live-time irradiations of samples from 10 to 100 mg of each ore are fitted by weighted least squares and the error for each determination is calculated. (auth)

35027 SEMICONDUCTOR INVESTIGATIONS USING RADIOCHEMICAL METHODS. Gebauhr, W. (Siemens AG, Erlangen, Ger.). Z. Anal. Chem., 245: 209-21(Apr. 29, 1969). (In German).

Various possible applications of radiochemical methods for solving problems in the development and manufacture of semiconductors are discussed. The sensitivity limits of activation analysis attainable by chemical separation make it possible to meet the demands of analysis resulting from the intrinsic concentration of the semiconductor. Details are also given of investigations using radiotracer methods, and of a number of applications of autoradiography. In many instances, autoradiography provides a solution to the important problem of localizing the impurities determined. (auth)

35028 SOME APPLICATIONS OF ACTIVATION ANALYSIS FOR THE DETERMINATION OF TRACE IMPURITIES IN SEMICONDUCTOR MATERIALS. Hoste, J.; DeSoete, D. (Ghent Univ.). Z. Anal. Chem., 245: 221-32(Apr. 29, 1969).

It is shown that activation analysis can be applied with success for the determination of trace impurities in semiconductor material. The specificity and sensitivity together with a reasonable reproducibility are demonstrated. As an example, a survey of the determinations carried out with Ge, Se, and Si matrices is given. (auth)

35029 DETERMINATION OF TRACE IMPURITIES IN GALLIUM AND GALLIUM ARSENIDE BY NEUTRON ACTIVATION ANALYSIS. Neeb, K. H.; Stoeckert, H.; Braun, R.; Bleich, H. P. (Siemens AG, Erlangen, Ger.). Z. Anal. Chem., 245: 233-9 (Apr. 29, 1969). (In German).

In neutron activation of gallium and gallium arsenide very high specific activities of the radionuclides ^{72}Ga and ^{76}As are formed. Their rather short half-life values of 14.1 and 26.5 h respectively permit relatively undisturbed determination of all foreign elements with long-lived radionuclides after a certain degree of decay of the matrix activities. These elements include Ag, Cd, Co, Cr, Fe, Hg, Ni, Zn, and others. However, for the determination of elements with short-lived radionuclides, such as Mn, Cu, and Ge, it is necessary to radiochemically process the highly radioactive sample (activity 1 to 10 Ci) behind suitable shielding as soon as possible after irradiation. Chemical separating schemes were developed for the determination of both long-lived and short-lived radionuclides. These can be varied easily according to the number and nature of the impurity elements to be determined. The sensitivity attainable under optimal irradiation conditions lies between 2×10^{-3} and 2×10^{-6} ppM. Possible disturbance of the analysis due to side reactions and contamination of the liquid gallium by impurities in the packing material during irradiation are discussed. (auth)

35030 DETERMINATION OF LIGHT ELEMENTS IN SILICON AND SELENIUM BY ION-ACTIVATION ANALYSIS. Schuster, E.; Wohlleben, K. (Siemens AG, Erlangen, Ger.). Z. Anal. Chem., 245: 239-44(Apr. 29, 1969). (In German).

Since elements with low atomic number either cannot be determined at all by activation with thermal neutrons or only with very poor detection limit, irradiation with ions (protons, deuterons, tritium ions, ^{3}He- and ^{4}He-ions) for activation analysis of the light elements has therefore gained increasing importance. There are basic differences between ion and neutron activation, which are discussed. Because of their relatively small range in matter, ions are particularly suited for analyzing surfaces as well as thin deposited films and corrosion layers. Since the activation depth can be established in advance by appropriate selection of the analysis parameters, the distribution of foreign matter in the matrix material can also be analyzed. Proton and deuteron reactions are employed to determine the presence of oxygen, nitrogen, and carbon, but other elements such as boron and aluminium can also be detected by ion activation. The detection limit attained in analyzing the elements mentioned is within the range of 1 to 100 ppB with an ion bombarding energy of 3.0 MeV, a flux density of 5 $\mu A/cm^2$ and an irradiation period which corresponds to the half-life of the element to be activated. A report is given on the determination of carbon in silicon and oxygen in thin-deposited selenium films and the results are discussed. (auth)

35031 DETERMINATION OF TRACE ELEMENTS IN DNASE I BY THE ACTIVATION ANALYSIS. Akaboshi, Mitsuhiko; Maeda, Toshio (Kyoto Univ.). Dobutsugaku Zasshi, 76: 235-8(July 1967). (In Japanese).

Commercially available DNase I (bovine pancreatic) was activated by exposing to a neutron flux of approximately 5×10^{12} $n/cm^2/sec$ for 30 min at the pneumatic tube of KUR (Kyoto University Reactor). Then, γ rays from ^{24}Na, ^{27}Mg, and ^{56}Mn and β from ^{32}P derived from the nuclear reaction ^{32}S(n,p)^{32}P were detected. By counting these radioactivities, contents of these elements in DNase I were determined. The results were as follows: Na; 0.275 to 1.675 μg/mg DNase I, Mg; 0 to 13.25 μg/mg DNase I, and Mn; 0.105 to 0.150 μg/mg DNase I. These elements could easily be removed by dialyzing DNase I against redistilled water. (NSA of Japan)

35032 USE OF PULSED REACTORS FOR ACTIVATION ANALYSIS. Com. Naz. Energ. Nucl., Notiz., 15: No. 1, 83-6 (Jan. 1969). (In Italian).

The use of short-lived radioisotopes, produced by neutron irradiation, has increased greatly in activation analysis in the last few years. The only pulsed reactor in Italy at present is the Lena. The production of short-lived isotopes, activation analysis with neutron pulses, and applications of this method are described briefly. (J.S.R.)

35033 DETERMINATION OF ARSENIC CONTENT OF AMERICAN CIGARETTES BY NEUTRON ACTIVATION ANALYSIS. Lee, Bong K.; Murphy, Glenn (Iowa State Univ. of Science and Technology, Ames). Cancer, 23: 1315-17(June 1969).

Instrumental neutron activation, in which no chemical separation is involved, was applied to the determination of arsenic content in American cigarettes. The technique has the merits of being nondestructive and having no significant interferences. Fifty-two samples of 33 brands of cigarettes were analyzed. The results show that one gram of tobacco contains, on the average 7.69 ± 0.48 μg of arsenic, ranging from 5.5 ± 0.34 μg to 12.8 ± 0.79 μg. (auth)

35034 A STUDY OF A QUANTITATIVE DETERMINATION OF INORGANIC IMPURITIES IN POLYPROPYLENE BY NEUTRON ACTIVATION-GAMMA SPECTROMETRY. Fukushi, Norio (Gunma Univ., Maebashi, Japan). Gunma J. Liberal Arts Sci., No. 2, 29-35(Oct. 1968).

The contents of Al, Ca, Ti, Cl, and Na in polypropylene were determined by γ spectrometry. The irradiations for neutron activation were carried out in TRIGA–Mark II reactor (The Institute for Atomic Energy, Rikkyo University) with neutron fluxes of about 1.6×10^{12} $n/cm^2/sec$. After the irradiation for a few minutes, γ spectra were recorded by the use of multichannel pulse height analyser. The results obtained by neutron activation were compared with those obtained by ordinary chemical methods. The nondestructive method has the advantages of minimizing the loss of elements determined and of being applicable to polypropylene samples for rapid analysis with satisfactory precision. (NSA of Japan)

35035 DETERMINATION OF FLUORINE, ON THE SURFACE OF METALLIC SAMPLES, BY THE REACTION ^{19}F(p,$\alpha\phi$)^{16}O. Barrandon, Jean-Noel; Seltz, Raymond (CNRS, Vitry-sur-Seine, France. CNRS, Strasbourg). Compt. Rend., Ser. C, 268: 1852-5 (May 28, 1969). (In French).

In previous experiments, the determination of oxygen and carbon present in the surfaces of samples was described. Now the possibility of determining fluorine by irradiation with a beam of protons at 1200 to 1450 keV utilizing the reaction ^{19}F(p,$\alpha\phi$)^{16}O is examined. This should make possible the detection of quantities of fluorine less than 0.001 $\mu g/cm^2$. (tr-auth)

35036 ACTIVATION ANALYSIS OF SELENIUM BY FAST NEUTRONS. Tustanovskii, V. T.; Orifkhodzhaev, V. At. Energ. (USSR), 26: 383-4(Apr. 1969). (In Russian).

Selenium belongs to a group of elements characterized by a high activation yield of induced activities on being irradiated with 14-MeV neutrons. Thus the (n,2n) cross sections on ^{78}Se and ^{80}Se to give ^{77m}Se (half-life = 17.5 sec) and ^{79m}Se (half-life = 3.9 min) are estimated to be 1.2 and 1.4 barns, respectively, from the Blatt–Weiskopf formula. The main source of selenium is in copper–nickel ores, and the effect of nuclear reactions on copper, tellurium, and nickel must be taken into account. At an optimum activation time of 30 sec to 1.0 min and a counting time of 1.0 min, it is calculated that the sensitivity threshold of determining selenium is 26 micrograms. The error of determining selenium in a mixture containing copper and tellurium was 50%. The induced gamma activities at 96 and 160 keV were measured on a well-type, sodium-iodide multichannel crystal counter. (TTT)

35037 SENSITIVITY OF ACTIVATION ANALYSIS FROM SHORT-LIVED ISOTOPES. Leushkina, G. V.; Lobanov, E. M.; Dutov, A. G.; Matveeva, N. P. At. Energ. (USSR), 26: 381-3 (Apr. 1969). (In Russian).

In determining sensitivities the short-lived activities of most frequently encountered elements were counted 0.5 seconds after irradiation at a flux of 3.8×10^{11} neutrons/$cm^2 \cdot$ sec on a 100-channel scintillation counter. The absolute activities of the isotopes were determined from the measured areas of the photopeaks. Calculated and experimental values of the sensitivity and of the cadmium ratio are given for the following short-lived isotopes (the half-life of the isotope is given in parentheses after the isotope): ^{167m}Er (2.5 sec), ^{183m}W (5.5 sec), ^{177m}Yb (6.5 sec), ^{197m}Au (7.2 sec), ^{20}F (10.7 sec), ^{89m}Y (15.0 sec), ^{77m}Se (17.5 sec), ^{179m}Hf (19.0 sec), ^{46m}Sc (19.5 sec), ^{110}Ag (24.2 sec), ^{109m}Ag (39.0 sec), ^{107m}Ag (44.0 sec), ^{105m}Rh (44.0 sec), ^{75m}Ge (54.0 sec), ^{139m}Ce (55.0 sec), ^{86m}Rb (61.0 sec), ^{165m}Dy (1.25 min), ^{142m}Ir (1.4 min),

^{71}Zn (2.2 min), ^{28}Al (2.3 min), ^{137m}Ba (2.6 min), ^{122m}Sb (3.5 min), ^{161m}Gd (3.6 min), ^{52}V (3.76 min), ^{109m}Pd (4.75 min), ^{66}Cu (5.1 min), ^{51}Ti (5.8 min), ^{94m}Nb (6.6 min), ^{27}Mg (9.4 min), ^{60m}Co (10.4 min), ^{101}Mo (14.6 min), ^{151}Nd (15.0 min), ^{80}Br (17.6 min), ^{188m}Re (18.7 min) and ^{70}Ga (21.0 min). (TTT)

35038 NEUTRON ACTIVATION ANALYSIS IN WATER RESOURCES MANAGEMENT FOR NORTH CAROLINA. Bohannon, James R.; Verghese, K.; Weaver, Jack N. (North Carolina State Coll. of the Univ. of North Carolina, Raleigh). Trans. Amer. Nucl. Soc., 12: 41(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35039 NEUTRON ACTIVATION ANALYSIS OF THE SELENIUM CONTENT OF FOSSIL FUELS. Pillay, K. K. S.; Thomas, Charles C. Jr.; Kaminski, Joseph W. (Western New York Nuclear Research Center, Inc., Buffalo). Trans. Amer. Nucl. Soc., 12: 41-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35040 IDENTIFICATION OF GOLD IN MIXTURES BY NEUTRON CAPTURE GAMMA RAYS. Elkady, Ahmed; Duffey, Dick (Univ. of Maryland, College Park). Trans. Amer. Nucl. Soc., 12: 42-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35041 NEUTRON ACTIVATION ANALYSIS DETERMINATION OF ALL 14 RARE-EARTH ELEMENTS: WITH GROUP SEPARATION AND Ge(Li) SPECTROMETRY. Graber, F. M.; Lukens, H. R.; MacKenzie, J. K. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 44(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35042 ASSAY OF URANIUM AND THORIUM BASED UPON REACTOR PULSE ACTIVATION AND DELAYED NEUTRONS. Lukens, H. R.; Guinn, V. P. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 45(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35043 NEUTRON ACTIVATION ANALYSIS AND HIGH RESOLUTION GAMMA-RAY SPECTROMETRY APPLIED TO AREAL ELEMENTAL DISTRIBUTION STUDIES. Wainerdi, R. E.; Uken, E. A.; Santos, G. G.; Yule, H. p. (Texas A and M Univ., College Station, Tex.). pp 507-32 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The applicability of automated, instrumental thermal neutron activation analysis techniques to large-scale areal elemental distribution determinations related to continental drift and to metallogenesis was studied. The Enchanted Rock batholith, Llano, Texas, was selected as an initial area in which to apply this method on the basis of the availability of independent geochemical information. Rock samples, including points from areas outside the batholith, were obtained at each of 16 sampling sites. One gram rock samples were irradiated in a thermal neutron flux of $\approx 2 \times 10^{12}$ n/cm^2 sec for 2 hours. Six trace elements (Hf, Ta, Co, Eu, Sc, and La), and one minor element (Fe), were determined by gamma-ray spectrometry utilizing a 19 cm^3 Ge(Li) detector and a 3200 channel analyzer, and were areally mapped. The results indicate continuous trends in each trace element, through various rock types, over a distance of greater than 50 miles. The trace elements of pyrite, chalcopyrite, and sphalerite obtained from the Philippine Islands were measured in order to apply this procedure to minerals in a location where their areal extent has not previously been extensively studied. The methodology described above was repeated. A set of average element abundances in chalcopyrite, pyrite, and sphalerite is suggested on which to base the presence or absence of an element province or combined elements provinces. Preliminary results indicate the presence of a gold province in the northwestern part of Luzon Island. This technique offers promise in mineral exploration in relatively undeveloped areas by showing both direct and indirect prospecting criteria. (auth)

35044 PRELIMINARY STUDY ON THE USE OF FAST-NEUTRON ACTIVATION ANALYSIS ON SEA-FLOOR COMPOSITIONAL MAPPING. Santos, G. G.; Fite, L. E.; Kuykendall, W. E.; Wainerdi, R. E.; Bouma, A. H.; Bryant, W. R. (Texas A and M Univ., College Station, Tex.). pp 463-87 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Fast neutron activation was applied to marine sediments for the purpose of characterizing chemical (elemental) compositional variations encountered on the ocean floor. Sediments collected from different depositional environments of the Gulf of Mexico were analyzed by 14 MeV neutron activation analysis techniques. A maximum total output flux of 1×10^9 n/cm^2 sec for 15 min was employed. A lower output flux and longer irradiation periods were also used for comparison purposes. Measurements indicate that, on the basis of silicon content alone, abyssal plain sediments can be easily differentiated from those of the continental slope, abyssal hills, continental rise, and the Mississippi Fan. The elements Fe, Mg, and Al are apparently silica dependent and may be used to gauge subtle variations within a particular depositional environment. Carbonate regions are distinguishable from the siliceous areas. It should be feasible to perform the analysis "in situ" from a submersible, or from the surface, using a portable system. (J.G.B.)

35045 PHOTO-NUCLEAR AND FAST NEUTRON ACTIVATION ANALYSIS OF COPPER IN COPPER ORES AND FLOTATION PRODUCTS. Pradzynski, A. (Office of the Government Commissioner for Atomic Energy, Warsaw). pp 451-62 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Two methods of activation analysis, photonuclear activation and fast neutron activation, were examined for the purpose of analytical control of copper content in ores, tailings, and concentrates. The precision of copper determination was better than 3.8% for photon activation and 4.9% for neutron activation. Calibration curves for both methods are given. The photonuclear activation method seems to be preferable because it is free from matrix effects. (auth)

35046 APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO GEOCHEMICAL STUDIES OF MINERAL RESOURCES. Winchester, J. W. (Univ. of Michigan, Ann Arbor); Catoggio, J. A. pp 435-49 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Activation methods available for geochemical analyses are reviewed. Sensitive and accurate measurement of closely related trace element concentrations in naturally occurring materials leads to the most useful geochemical information in the study of crystallizing systems. Studies of the rare earth elements have shown regularities that can be related to geological crystallization processes in igneous and sedimentary materials, and it is likely that similar studies of economic mineral deposits will lead to similar information. Neutron activation analysis and spark source mass spectrometry have high sensitivity adequate for many geochemical applications. However, simpler methods, such as atomic absorption, absorption spectrophotometry, and electrochemical methods have adequate sensitivity for many elements and are preferred when suitable. (auth)

35047 THE DETERMINATION OF MERCURY IN RENAL PUNCTATE BY MEANS OF NEUTRON ACTIVATION ANALYSIS. Henke, G.; Westerboer, S.; Portheine, H. (Univ., Muenster, Ger.). Arch. Toxikol., 23: 293-8(1968). (In German).

A report is given of the detection by means of neutron activation of mercury in kidney needle biopsy material as well as in blood and urine from a female patient who had been treated 12 years with mercury precipitate ointment. Three years after termination of the treatment there could still be detected 94.5 ppM of mercury in the kidney biopsy material (4.8 mg fresh weight), 0.0047 ppM in the blood, and 0.33 ppM in the urine. The amount of mercury found in the kidney material was 200 times higher than that listed as normal in the literature. (auth)

35048 NEUTRON ACTIVATION AUTORADIOGRAPHY OF OIL PAINTINGS. Sayre, Edward V.; Lechtman, Heather N. (Massachusetts Inst. of Tech., Cambridge). Stud. Conserv., 13: 161-85(1968). (BNL-12012).

A very moderate, non-destructive radioactivation of oil paintings, induced by thermal neutron bombardment, such that approximately only one in 10^{12} of the atoms comprising any painting is transformed into a radioactive species, has been found to produce temporary radioactivity sufficient to expose photographic film placed in direct contact with the paintings. The resulting autoradiographs resemble conventional x radiographs in that they

reveal structural details in depth of both the painting and its support. Since the radioactivities arising from the different elements within a painting decay in different manners and at different rates, a series of significantly distinct autoradiographs can be obtained of any painting by making exposures through appropriate filters and at varying times following the original activation. Analysis of such a series of autoradiographs permits the identification of a number of the pigments used in a painting, together with information about the manner in which they were originally laid down by the artist and their distribution throughout the body of the painting. Preliminary investigations have shown that the stability of oil paintings is unaffected by the activation procedure. The inherently necessary radiation dose absorbed by a painting as a result of activation sufficient for autoradiography is of the order of 50 rads. Paintings subjected to absorbed doses one hundred times as great as the dose necessary for autoradiography exhibit no changes in color, hardness, flexibility, and solubility three years after their original activation. (auth)

35049 (γ,n) ACTIVATION ANALYSIS OF SEVERAL ELEMENTS. Azuma, Toshio; Sato, Yuji; Turugi, Jituo; Miki, Ryota; Kondo, Yoshihide. Annu. Rep. Radiat. Center Osaka Prefect., 9: 26-9(1968).

The data of (γ,n) activation are reported for Au, Ti, Mo, Sn, and Fe and rubber samples, using the electron linac of 16 MeV, 30 μA. The standard element to estimate the Bremsstrahlung flux is an Au foil. The yield of Fe (γ,p) reaction is calculated. The Zn contents in rubber samples are measured for 7 pieces. (auth)

35050 NEUTRON ACTIVATION DETERMINATION OF MICROIMPURITIES IN SELENIUM OF HIGH PURITY. Gilbert, E. N.; Pronin, V. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 4, Ser. Khim. Nauk, No. 2, 168-70(Mar. 1969). (In Russian).

A neutron activation method is described for determination of 18 impurities in selenium, found on extractive separation of the elements. The following combination of organic solvents was employed for the extraction of the elements: dimethylbenzylalkylammonium chloride, di-n-butylthiophosphoric acid, and β,β'-dichlorodiethyl ether. (auth)

35051 NEUTRON ACTIVATION ANALYSIS OF URANIUM IN GEOLOGICAL MATERIAL BY MEASURING ^{132}Te. Suttle, A. D. Jr.; O'Brien, Barbara C.; Mueller, D. W. (Texas A and M Univ., College Station). Anal. Chem., 41: 1265-9(Aug. 1969).

A simple and sensitive method was developed for determining submicrogram quantities of uranium in geological material using neutron activation. A fission product of ^{235}U, ^{132}Te, is separated radiochemically from the irradiated sample, determined by gamma spectrometry, and related to the uranium concentration of the original material. The radiochemically separated ^{132}Te emits a high intensity gamma ray at 230 keV, which is free from interference from any other radionuclide. Under existing irradiation conditions (3×10^{12} n cm^{-2} sec^{-1} for 10 hours), 50 nanograms of uranium can be determined with a precision of +3.5%. The proposed method has the advantages of precise determination of submicrogram and microgram quantities of uranium in geological samples with a minimum of specialized equipment. (auth)

35052 DETERMINATION OF THE IODINE RELEASE IN HUMAN URINE FROM A SYNTHETIC CURARE-LIKE COMPOUND BY NEUTRON ACTIVATION ANALYSIS. Moauro, A.; Marangio, G.; Dobici, F. (CNEN, Rome). Minerva Fisiconucl., 11: 109-11(1967).

Neutron activation was used to determine I in urine samples from patients injected with Sincurarina (a curare-like synthetic compound used as an anesthetic agent) before ordinary surgical treatment. The results showed an increasing I concentration against the time lapsed from injection. In all cases I was detectable 3 min after Sincurarina injection. The I determination by activation analysis was found to be very important as a quantitative determination of the Sincurarina when its presence is known or suspected as a result of biological analyses. (P.C.H.)

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Refer also to abstracts 35005, 35132, 35143–35145, 35153, 35161, 35208, 35213, 35247, 35282, 35292, 35442, 35544, 35994, 36182, 36251, 36802, 36803, and 37502.

35053 (CEA-R-3793) CHRONOPOTENTIOMETRY IN MOLTEN CHLORIDES. APPLICATION TO THE STUDY OF THE ELECTROCHEMICAL PROPERTIES OF URANIUM AND PLUTONIUM IN THE LiCl–KCl EUTECTIC. Leseur, Andre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1969. 98p. (In French). Dep.

Using solutions of cadmium chloride in the eutectic LiCl–KCl, a chronopotentiometric method was developed with a view to its application to the study of molten solutions. Particular attention was paid to the choice of the indicator electrodes. The method makes it possible to analyze molten solutions quantitatively and to determine diffusion coefficients and their activation energies; it also yields information about the nature and the behavior of ionic species in solution. The method was applied to the study of solutions of uranium and plutonium chloride in the eutectic LiCl–KCl. Linear chronoamperometry was used for studying these solutions quantitatively, but chronopotentiometry, for which the theory is better developed, is better suited to a quantitative study. Results made it possible to determine the diffusion coefficients of the Cd^{2+}, U^{3+}, U^{4+}, and uranyl ions in the presence of F^- and Pu^{3+} ions, as well as the activation energy of the diffusion coefficients. (auth)

35054 (COO-733-18) A. THE PREPARATION OF DILUTE, DRY, NONAQUEOUS SOLUTIONS OF MOLECULAR IODINE INOCULATED WITH ^{131}I. B. THE DISTRIBUTION OF MOLECULAR IODINE BETWEEN CYCLOHEXANE AND AQUEOUS SOLUTIONS. Van de Steeg, Garet E. (New Mexico Univ., Albuquerque). June 1968. 213p. Dep. CFSTI.

Thesis.

The preparation of dilute, dry, nonaqueous solutions of molecular iodine labeled with ^{131}I was carried out by isotopic exchange of iodine atoms between ^{131}I activity adsorbed on a platinum surface and the molecular iodine in solution. This procedure permits the preparation of dilute, dry solutions of molecular iodine, in a number of nonaqueous solvents, which incorporate appropriate amounts of ^{131}I without introducing any known or measurable impurities into the solution, without affecting the iodine concentration, without changing the chemical nature of the dissolved iodine, and without introducing into the solutions ^{131}I species that behaved in a manner other than that expected of molecular iodine. Another procedure, involving isotopic exchange of iodine atoms between iodide-131 adsorbed on the surface of preformed silver iodide precipitates and molecular iodine in solution, was investigated briefly; this procedure, however, was not as satisfactory as the procedure employing the use of platinum. The distribution of iodine between cyclohexane and aqueous solutions was investigated. The distribution coefficient was found to be dependent on the pH and ionic strength of the aqueous phase, the initial concentration of iodine in the cyclohexane, the duration of the mixing process for the cyclohexane–iodine–aqueous system and the purity of the cyclohexane. ^{131}I species, which did not behave as molecular iodine, iodide, or hypoiodite, were observed in both the cyclohexane and aqueous phases of the two-phase reaction mixture after 24 hours or more mixing time. A mechanism, encompassing reactions between iodine and impurities originally present in the cyclohexane, is proposed to explain the observed behavior of the distribution coefficient. (auth)

35055 (EUR-4235) MEASUREMENTS OF FOULING OF TERPHENYLS. Angelini, G. L.; Hoepper, M.; van Rutten, F. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 9, 1968. 24p. (In French). Dep.

Equipment is described that allows reproducible measurements of the fouling of terphenyls. It consists of an electrically heated horizontal tube on which fouling is deposited. A quantity of 150 g of terphenyl is used for each test. The measurements show that the deposits obtained depend on the impurities content of the terphenyl, on the diameter of the tube, on the temperature, and on the mode of heating of the tube. (auth) (Euratom)

35056 (FZK-351-2) NERVA IRRADIATION PROGRAM: GTR TEST 21. VOLUME 2. NUCLEAR-RADIATION-INDUCED CONVERSION OF PARAHYDROGEN TO ORTHOHYDROGEN. Nelms, L. W.; Carter, H. G. (General Dynamics/Fort Worth, Tex.). May 15, 1968. Contract AF29(601)-7077. 150p. Dep. CFSTI.

An experiment designed to investigate the conversion of parahydrogen to orthohydrogen by nuclear radiation is described. A model for conversion is postulated that assumes that certain products formed in liquid parahydrogen during irradiation ultimately cause conversion in the gas. To test the model, samples of liquid parahydrogen (up to 15 gal/sample) were irradiated by the Ground Test Reactor (GTR). Measurement of the orthohydrogen content of the effluent was by means of a continuous flow gas analyzer of the thermal-conductivity type. Irradiation data were obtained covering a gamma range of from 1.7×10^8 to 1.2×10^9 ergs/g(C)/hr and a neutron range from 2.2×10^{14} to 1.6×10^{15} n/cm^2/hr (E > 1.0 MeV). Large amounts of conversion were observed, the highest reported being reduction of 99% p-H_2 to 38% p-H_2 (≈ 49% relative conversion). The conversion was unmistakably due to nuclear radiation. (D.H.M.)

35057 (ORNL-4381) RATES OF GAS EVOLUTION FROM THE REACTIONS OF URANIUM AND THORIUM CARBIDES WITH AQUEOUS SOLUTIONS OF HCl, H_2SO_4, NaOH, AND NH_4F. Sears, Mildred Bradley; Ferris, Leslie M. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Gas evolution, as a function of time, is shown graphically for the reactions of 3- to 4-g specimens of arc-cast uranium and thorium carbides with aqueous solutions of HCl, H_2SO_4, NaOH, and NH_4F. (auth)

35058 (ORNL-TM-2596) FRACTIONAL CRYSTALLIZATION REACTIONS IN THE SYSTEM LiF-BeF_2-ThF_4. Thoma, R. E.; Ricci, J. E. (Oak Ridge National Lab., Tenn.). July 8, 1969. 33p. Dep. CFSTI.

Equilibrium and nonequilibrium crystallization reactions in the system LiF-BeF_2-ThF_4 were analyzed in relation to their potential application to molten salt reactor fuel reprocessing. Heterogeneous equilibria in the temperature range from the liquidus at 590°C to the solidus at 350°C are described quantitatively and in detail by means of ten typical isothermal sections and by three temperature-composition sections. The implications of metastable fractionation in this temperature interval are discussed as a possible feed control step in reductive extraction reprocessing of molten salt breeder reactor fuels. (auth)

35059 PLUTONIUM-DOKUMENTATION: MIT ANHANG TRANSPLUTONIUM-ELEMENTE. April 1969. Band 3, Heft 4. 160 Referate (Register-Nr. 1069-2392). (Plutonium-Documentation: With Appendix on Transplutonium Elements. Vol. 3, No. 4, 160 References (No. 1069-1392). Karlsruhe, Ger., Gesellschaft fuer Kernforschung M. B. H., 1969. 108p. (In German and English).

One hundred sixty references are included on the following topics: physical properties of plutonium, its alloys, and its compounds; chemistry of plutonium and its compounds, reprocessing and isotope separation; alloys and metal-metalloid systems with plutonium; plutonium production by nuclear reactions; handling of plutonium; utilization of plutonium; economic problems, development programs; and, history and bibliographies. (J.G.B.)

35060 CHEMICAL APPLICATIONS OF RADIOISOTOPES. Bowen, H. J. M. London, Methuen and Company, 1969. 142p. 30s.

The following topics are discussed: Properties of radioisotopes; physical applications of tracers; applications in testing separation techniques; applications in chemical analysis; equilibrium studies with isotopes; studies on chemical pathways; also miscellaneous studies with radioisotopes. (UK)

35061 H_2-D_2-EXCHANGE ON REDUCED IRON OXIDE CATALYSTS. Brill, R.; Kleiner, D.; Schaefer, H. (Max-Planck-Gesellschaft zur Foerderung der Wissenschaften e.V., Berlin). Ber. Bunsenges. Phys. Chem., 73: 267-74(May 1969). (In German).

The H_2-D_2 exchange reaction was measured between 130 and 400°K, on iron catalysts, as a function of pressure and composition of the gas mixture. Different activation energies were found at different intervals of temperature: 1.5 kcal/mol below 160°K, 7.3 kcal/mol between 200 and 250°K, 4.4 kcal/mol between 270 and 360°K, and 8.1 kcal/mol above 370°K. The activity depends upon the ratio H_2: D_2. The mechanisms prevailing at different intervals of temperature are discussed. In this connection adsorption measurements are taken into account. The influence of transport phenomena is also considered. (auth)

35062 LIGAND EFFECT OF THE ASSOCIATION-DISSOCIATION EQUILIBRIUM OF URANYL COMPOUNDS IN ORGANIC SOLVENTS. Jezowska-Trzebiatowska, B.; Ernst, S. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 17: 93-9(1969).

Electrolytic conductance was measured for anhydrous and monohydrous uranyl chloride in methanol, ethanol, and n-propanol at 15, 25, and 35°C and uranyl chloride monohydrate in n-pentanol at 25°C. Results were compared with previously reported data on uranyl nitrate. The investigation indicated a dual effect of hydration on the association-dissociation equilibrium. The effect depends on the type of cation-anion bond and on the specific properties of the anion. (J.G.B.)

35063 COMPLEX CARBONATES OF THE LANTHANIDES. Fromage, Francine (Faculte des Sciences, Reims, France). Ann. Chim. (Paris), 3: 457-67(Sept.-Oct. 1968). (In French).

The compounds of formula $A(Ln(CO_3)_3 \cdot nH_2O$, $A_3(Ln(CO_3)_3 nH_2O$, and $A_5(Ln(CO_3)_4 \cdot nH_2O$, whose solubilities in carbonate and bicarbonate solutions vary so greatly as to be of interest for separations applications, were prepared; here A = alkali metal, Ln = lanthanide. Solubilities, mechanisms of thermal decomposition, and stability in the presence of A_2CO_3 and $AHCO_3$ solutions were studied. Variation in the composition of the solid carbonate after equilibration with carbonate solutions is illustrated. Solubilities in ion g/l × 10^4 in 0.2M K_2CO_3 and 0.2M $KHCO_3$ after one hr agitating and 24 hr agitating vary for the lanthanides by more than two orders of magnitude, as follows: La, 1.1, 0.75; Pr, 1.3, 0.85; Nd, 2.2, 1.95; Sm, 7.5, 5; Eu, 32, 12; Gd, 38, 14; Tb, 60, 24; Dy, 102, 86; Ho, 175, 68; Er, 225, 120; Tm, 245, 205; Yb, 275, 235; Lu, 315, 295. Thus the possibility for application to separation exists. (BBB)

35064 VARIATIONS IN THE MECHANISM OF ISOTOPIC EXCHANGE OF THE HYDROGEN OF CYCLOHEXANE AS A FUNCTION OF THE CONDITIONS OF NdY ZEOLITE TREATMENT. Minachev, Kh. M.; Dmitriev, R. V.; Markov, M. A.; Shchukina, O. K. Kinet. Katal., 10: 210-13(Jan.-Feb. 1969). (In Russian).

Isotopic exchange of cyclohexane on NdY proceeds, in relation to the conditions of treatment with the catalyst, by two different mechanisms: the mechanism of simple exchange on oxide catalysts and the mechanism of multiple exchange on metals. The reversible change of the mechanism of the exchange reaction between cyclohexane and deuterium on treatment of NdY by deuterium and air was interpreted as the result of reversible changes in the state of the active centers. (tr-auth)

35065 REDUCTION OF THE β-DIOXIDE OF URANIUM BY HYDROGEN IN THE PRESENCE OF ADDITIONS OF Y_2O_3. Pis'menko, V. T.; Vlasov, V. G.; Larin, A. A. Kinet. Katal., 10: 203-6(Jan.-Feb. 1969). (In Russian).

Introductions of additions of Y_2O_3 in U_4O_9 causes acceleration of the process of reduction of the oxide by hydrogen. The catalytic action of Y_2O_3 is connected with the number and type of defects generated in the reduced oxide. (tr-auth)

35066 HOMOMOLECULAR CO_2 ISOTOPIC EXCHANGE ON METAL OXIDES OF THE IVTH GROUP. Boreskov, G. K.; Kasatkina, L. A.; Amerikov, V. G. Kinet. Katal., 10: 102-12 (Jan.-Feb. 1969). (In Russian).

Homomolecular isotopic exchanges between CO_2 and CuO in the temperature range from -78 to 350°C and pressures of CO_2 from 40 to 215 mm were studied. Results of the investigation were compared with those previously obtained for oxides of Cr, Mn, Fe, Co, Ni, and Zn. Results are also given for heteroisotopic exchange between CO_2 with oxygen in Cr_2O_3, Fe_2O_3, and CuO. Possible mechanisms of isotopic exchange were investigated. (tr-auth)

35067 CHEMISTRY OF LANTHANONS. XXI. RARE EARTH COMPLEXES OF SOME HETEROCYCLIC CARBOXYLIC ACIDS. Dutt, N. K.; Nag, K. (Indian Association for Cultivation of Science, Calcutta). J. Inorg. Nucl. Chem., 31: 1867-9 (June 1969).

The formation constants of rare earth complexes with quinaldic acid, 8-quinolinecarboxylic acid, 2-quinoxalinecarboxylic acid, and 3-hydroxypicolinic acid are reported. The solubility products of rare earth quinaldinates were also evaluated. (auth) (UK)

35068 PREPARATION AND PROPERTIES OF LANTHANIDE COMPLEXES OF SOME β-DIKETONES. Ismail, M.; Lyle, S. J.; Newbery, J. E. (Univ. of Kent, Canterbury, Eng.). J. Inorg. Nucl. Chem., 31: 1715-24(June 1969).

The preparation, thermal stability, volatility and spectral characteristics of lanthanide(III) complexes formed from 1,1,1-trifluoromethyl-5,5-dimethyl-2,4-hexanedione (HPTA), 1,1,1-trifluoromethyl-4-phenyl-1,3-butanedione (HBTA), and 1,3-diphenyl-1,3-propanedione (HDBM) are described. Under the conditions (aqueous or aqueous ethanol solution) employed HPTA gave rise to tetrakis chelates, HBTA to (hydrated) tris chelates, and HDBM to basic polymeric products. The tetrakis chelates $M[Ln(PTA)_4]$, where M^+ is an alkali metal cation, were all volatile. Those with $M^+ = Ph_4As^+$ and $M^+ = Et_4N^+$ were non-volatile, although still of high thermal stability. (auth) (UK)

35069 VALENCE OSCILLATIONS OF $[^{16}OU^{18}O]^{2+}$ IN URANYL COMPLEXES. Vdovenko, V. M.; Mashirov, L. G.; Suglobov, D. N. Dokl. Akad. Nauk SSSR, 185: 824-7(Apr. 1, 1969). (In Russian).

The frequencies of the valence oscillations of the uranyl ion can be used to find the length and binding energy of the uranium-oxygen in uranyl complexes by means of known correlations between the bond force constant (K) and various structural parameters. In order to calculate precise values of K it is necessary to know the frequency of the completely symmetrical oscillation ν_s as well as the frequency ν_{as} measured in the infrared spectrum. The infrared spectra of a series of uranyl complexes enriched 50% with oxygen-18 were measured in order to determine the frequencies of ν_s and ν_{as}. It was assumed that in the $[^{16}OU^{18}O]^{2+}$ spectrum, due to the lowered symmetry of this ion,

ν_s should be active in absorption. The $UO_2Cl_2 \cdot H_2O$ compound served as the initial product for all subsequent syntheses of uranyl complex compounds (fluorides, iodides, bromides, carbonates, nitrates, amines, etc.). The measured frequencies of the valence oscillations of various isotopic forms of the uranyl ion, the force constant K calculated from the frequencies, and the force constant of the bond interaction are tabulated. Calculated values agree satisfactorily with experimental values within the accuracy of measurement on assuming a linear isolated group for $[^{16}OU^{18}O]^{2+}$. The relations that were observed can be used to determine ν_s if only ν_{as} is known, and can also be used as criteria in assigning a band to the oscillations of the uranyl ion. (TTT)

35070 LANTHANIDE COMPLEXES. IX. COMPLEXES OF LANTHANIDE SALTS WITH DIBUTYLBIPYRIDINES. Hart, F. A.; Newbery, J. E. (Queen Mary Coll., London). J. Inorg. Nucl. Chem., 31: 1725-33(June 1969).

Lanthanide nitrates, thiocyanates, and chlorides form complexes, soluble in inert organic solvents, with the ligands 4,4′-di-n-butyl-2,2′-bipyridine and 5,5′-di-n-butyl-2,2′-bipyridine. Structures and bonding are discussed in the light of colligative measurements, ir spectra, and electronic spectra in absorption and fluorescence. (auth) (UK)

35071 THE COMPUTATION OF THE EQUILIBRIUM VAPOR COMPOSITION OVER UO_{2+x}. Fontana, M. H. (Oak Ridge National Lab., Tenn.); Bailey, R. E. Nucl. Sci. Eng., 36: 268-74 (June 1969).

A method was developed for computing the partial pressures of various equilibrium vapor species existing above nonstoichiometric UO_{2+x}. The gas phase oxygen-to-uranium atom ratio was correlated with the oxygen-to-uranium ratio in the solid, which was known. The atom ratio, total pressures, and equilibrium constants of formation of each compound, sufficiently specify the system to allow the computation of the gas phase concentrations using multicomponent chemical equilibria computer techniques. The results agree with independent experimental data. (auth)

35072 ADSORPTION AND DIFFUSION OF ^{137m}Ba FROM Na–^{137}Cs SOLUTION. Cooper, M. H.; Taylor, G. R. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 57-8(June 1969).

35073 EFFECTS OF COOLANT CHEMISTRY ON CORROSION AND CORROSION PRODUCTS. Fletcher, Wilson D. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 70(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35074 POSSIBLE STABILIZATION OF NITRIDE FUEL BY OXYGEN. Leitnaker, J. M.; Beatty, R. L.; Spear, K. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 86-7 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35075 EQUILIBRIA BETWEEN H_2 AND Zr_4Sn AT TEMPERATURES UP TO 712°C. Jansson, Sven A.; Gulbransen, Earl A. (Westinghouse Research Labs., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 100-1(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35076 IRON CARBIDE/LIQUID SODIUM REACTIONS. Yannopoulos, L. N.; Charles, R. G. (Westinghouse Research Labs., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 123(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35077 SOLUBILITY OF Fe_3O_4 IN DILUTE ACID AND BASE SOLUTIONS TO 300°C. Sweeton, F. H.; Baes, C. F. Jr.; Jenks, G. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 82(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35078 FISSION PRODUCT SEGREGATION IN LOW-TEMPERATURE FUEL. Grossman, L. N.; Wolff, U. E. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 12: 74-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35079 ENERGY TRANSFER, MIGRATION, AND DIFFUSION IN AROMATIC LIQUID SOLUTIONS. Birks, J. B. (Univ. of Manchester, Eng.). pp 203-21 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

The mechanism of electronic energy transfer from molecules of a liquid aromatic solvent to those of a fluorescent aromatic solute is discussed; such energy transfer is a fundamental process occurring in organic liquid scintillators. The solvent is normally benzene or one of its alkyl derivatives, such as toluene or p-xylene, or a liquid alkyl naphthalene; and the solute may be, for example, p-terphenyl, 2-5-diphenyloxazole, or 9,10-diphenylanthracene. Headings are as follows: Choice of scintillator solute; monomeric solvent-solute energy transfer; experimental studies of solvent-solute energy transfer; theory of monomeric solvent-solute energy transfer process; solvent excimerisation; excimeric solvent-solute energy transfer; relation of solvent excimerisation to diffusion and migration; the solvent-solute energy transfer process. (UK)

35080 CHEMISTRY OF THE ELECTRON IN CONDENSED MEDIA. Brown, D. M.; Dainton, F. S. (Univ. of Leeds, Eng. Univ. of Nottingham, Eng.). pp 35-59 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

A brief description is given of the general chemistry of the electron and the thermodynamics of its reactions, followed by a description of the means of preparation of solvated electrons and H atoms, the method of identification and physical properties of the electron in various states of aggregation, diagnostic reagents for the electron and the H atom, the relative reaction rates of these two entities, and various other related matters. Headings are as follows: preparation of homogeneous solutions in condensed media of H atoms and electrons; physical properties of the solvated and trapped electron in aqueous media; diagnostic reagents for the electron and for H atoms; relative rates of reaction of two solutes; specific rate constants for electron reactions; lifetime of the ion atmosphere of the aquated electron; the reaction $H + OH^-_{aq} \rightarrow e^-_{aq}$; and the electron in other media. (UK)

35081 ISOTOPIC EXCHANGE BETWEEN OXYGEN AND CARBON MONOXIDE IN SHOCK WAVES. Garnett, S. H.; Kistiakowsky, G. B.; O'Grady, B. V. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 51: 84-91(July 1, 1969).

The isotopic exchange reaction between $^{18}O_2$ and CO was studied in a shock tube coupled to a time-of-flight mass spectrometer, over the temperature range 1700 to 2600°K, using very dilute CO + O_2 mixtures in neon. The rate increased with time. Auxiliary studies of the $^{18}O_2$–$^{18}O_2$ exchange reaction and of the $^{18}O_2$–$C^{16}O$ exchange reaction induced by nitrous oxide pyrolysis demonstrated that this exchange occurs via an atomic mechanism. The rates of O-atom attack on O_2 and CO are found to be almost equal over the temperature range studied. Using the known rate of N_2O decomposition, at 1820°K the calculated rate constants for these two reactions are 11×10^{-12} and 6.6×10^{-12} cm^3 molecule^{-1} sec^{-1}, respectively, in excellent agreement with the extrapolations of the low-temperature values in the literature. The reaction producing O atoms in the absence of N_2O is equal order in both O_2 and CO but the overall order is uncertain. The observed activation energy of the initiation process is less than that suggested in the literature. Oxygen-atom concentrations, which are a factor of 30 greater than calculated from the literature values, of the rate coefficients of the reaction $CO + O_2 \rightarrow CO_2 + O$ indicate that some chain multiplication process, possibly involving trace impurities, is occurring. (auth)

35082 SPECTRA AND STRUCTURE OF CRYSTALLINE CYCLOPROPANE AND CYCLOPROPANE-D_6. Bates, John B.; Sands, Donald E.; Smith, William Hayden (Univ. of Kentucky, Lexington). J. Chem. Phys., 51: 105-13(July 1, 1969).

Infrared and Raman spectra of polycrystalline C_3H_6 and C_3D_6 were measured between 10 and 3500 cm^{-1} at 85°K. Infrared spectra of mixed C_3H_6 and C_3D_6 crystals were also obtained. From these measurements, an assignment of the origin of the multiplet splittings is proposed. An x-ray diffraction study of crystalline C_3H_6 suggests an orthorhombic unit cell with a = 10.0, b = 6.8, and c = 5.1 Å. Density measurements, spectroscopic data, and diffraction data indicate that the site group is C_s and that the space group is one of eight primitive D_{2h} groups Far-infrared spectra of crystalline C_3H_6 showed five absorptions attributed to k = 0 external modes. (auth)

35083 DEUTERIUM ISOTOPE EFFECT UPON A BIMOLECULAR DEHYDROCHLORINATION OF t-BUTYL CHLORIDE IN ACETONITRILE. Kevill, Dennis N.; Dorsey, James E. (Northern Illinois Univ., DeKalb). J. Org. Chem., 34: 1985-7(June 1969).

In a study of the deuterium isotope effect upon the biomolecular

dehydrochlorination of tert-butyl chloride in acetonitrile, chloride ion was used as reagent to promote the reaction. The deuterium isotope effect, k_3^H/k_3^D, was found to be 3.81 ± 0.21. (D.H.M.)

35084 THE ADSORPTION OF URANIUM HEXAFLUORIDE. IV. Mueller, L.; Fay, L. (Mecsek Ore Mining Enterprise, Pecs, Hungary. Univ. of Chemical Industries, Veszprem, Hungary). Acta Chim. Acad. Sci. Hung., 60: 1-15(1969).

From the point of view of elucidation of convection-free UF_6 diffusion-adsorption processes, the knowledge of functions for solution of nonstationary transient transport is of importance. For determination of the transient functions of a convection-free diffusion-adsorption operational unit, a mathematical model, taking into consideration the adsorption isotherm of Freundlich, and assuming rapid, instantaneous kinetics, was interpreted. The solution function is discussed, and the calculated values of the f(C, l, t) function are presented for a model of given parameters. (auth)

35085 MAGNETIC SUSCEPTIBILITY STUDIES AND POSSIBLE GROUND STATE CRYSTAL FIELD SPLITTING OF TWO ORGANOMETALLIC NEPTUNIUM(IV) COMPLEXES. Fischer, R. D. (Technische Hochschule, Munich); Laubereau, P.; Kanellakopulos, B. Z. Naturforsch., 24a: 616-20(Apr. 1969).

Extensive paramagnetic susceptibility studies between liquid helium and room temperature were carried out on polycrystalline samples of the two organometallic Np(IV) complexes $Np(C_8H_8)_4$ and $(C_5H_5)_3NpCl$. From a combined interpretation of the corresponding $1/\chi_m$-vs-T and μ_{eff}^2-vs-T-curves, respectively, is suggested that, in accordance with the tetrahedral molecular symmetry to be assumed for $Np(C_8H_8)_4$, a cubic Γ_8 crystal field level should lie lowest in this compound. The zero field splitting is apparently smaller than 5 cm^{-1}. (auth)

35086 D_2O VAPOR PRESSURE OF SATURATED SALT SOLUTIONS. Becker, M.; Schaelike, W.; Zirwer, D. (Deutsche Akademie der Wissenschaften, Berlin). Z. Naturforsch., 24a: 684-5(Apr. 1969). (In German).

Vapor pressure differences of H_2O and D_2O as well as saturated salt solutions in H_2O and D_2O were determined as a function of temperature. The salts studied were KNO_3, KCl, NaCl, NaBr, KNO_2, CH_3COOK, and LiCl. (M.C.G.)

35087 PHOSPHORESCENCE LIFETIMES OF DIDEUTERONAPHTHALENES. Gierke, Timothy D.; Watts, Richard J.; Strickler, S. J. (Univ. of Colorado, Boulder). J. Chem. Phys., 50: 5425-6(June 15, 1969).

The phosphorescence lifetimes of several different dideuteronaphthalenes were investigated. Results were analyzed by a least-squares method and they support the difference between α and β substitution found by others. It did not seem to matter whether the two deuterium atoms were adjacent, in the same ring, or on different rings; the only important factor was whether they were in the α or β positions. (M.C.G.)

35088 LOW-FREQUENCY INFRARED AND RAMAN SPECTRA OF HYDROGEN-BONDED PYRIDINIUM HALIDES. Foglizzo, R.; Novak, A. (CNRS, Paris. Faculte des Sciences de Paris). J. Chem. Phys., 50: 5366-73(June 15, 1969).

The infrared spectra of crystalline $C_5H_5NH^+Cl^-$, $C_5H_5NH^+Br^-$, $C_5H_5NH^+I^-$, and their deuterated derivatives at room and liquid-nitrogen temperature were investigated in the 4000 to 1500, and 300 to 20 cm^{-1} ranges. The Raman spectra of these compounds were examined below 300 cm^{-1}. All six infrared-active and four of the nine Raman-active lattice modes were observed for pyridinium chloride. The lattice frequencies of pyridinium halides were assigned in terms of translational and rotational as well as hydrogen-bond vibrations. The hydrogen-bond stretching frequencies were identified at 192, 133, and 110 cm^{-1} for chloride, bromide, and iodide, respectively. The relationships between the NH and (NH) ... X stretching frequencies and shapes of the corresponding absorption bands are discussed. (auth)

35089 REACTIONS OF 2.8-eV TRITIUM ATOMS WITH METHANE. Chou, C. C.; Rowland, F. S. (Univ. of Kansas, Lawrence). J. Chem. Phys., 50: 5133-40(June 15, 1969).

Tritium atoms with 2.8-eV kinetic energy were formed by 1849-Å photolysis of TBr, and were reacted with CH_4 in the presence of Br_2. In addition to HT from the abstraction reaction known in thermal systems, the direct substitution of T for H to form CH_3T was observed. The ratio of HT/CH_3T is 3.6 to 4.0 in low Br_2 mole fraction. In Br_2 mole fractions exceeding 0.5, this ratio is reduced to 3.0, and the absolute yields of both HT and CH_3T are greatly reduced. The formation of HT and CH_3T from hot reactions of T with CH_4 competes with the hot reaction of T with Br_2 to form TBr. (auth)

35090 INFRARED SPECTRUM OF THE DIFLUOROMETHYL RADICAL IN SOLID ARGON. Carver, T. Granville; Andrews, Lester (Univ. of Virginia, Charlottesville). J. Chem. Phys., 50: 5100-7(June 15, 1969).

When $HCBrF_2$ and $DCBrF_2$ at high dilution in argon are codeposited with an atomic beam of lithium on a CsI window at 15°K, lithium bromide absorptions appear along with several new absorptions not present when the precursor was deposited without alkali metal. These new absorptions are assigned to the antisymmetric hydrogen bending and carbon-fluorine stretching modes and the symmetric C–F vibration of the HCF_2 and DCF_2 radicals. The antisymmetric vibrational assignments are supported by product rule and normal coordinate calculations which give the potential constants F_{33} = 5.27 ± 0.1 mdyn/Å, F_{34} = 0.44 ± 0.02 mdyn/rad, and F_{44} = 0.64 ± 0.05 mdyn · Å/rad^2. An approximate force constant F_{22} = 7.19 ± 0.7 mdyn/Å is calculated from the symmetric C–F vibration. The carbon-fluorine valence force constant for HCF_2 is in the range of those for typical fluorocarbons. (auth)

35091 MANY-BODY CORRECTIONS TO ISOTOPIC VOLUME DIFFERENCES IN SOLID NEON. Brown, J. S. (Univ. of Vermont, Burlington). J. Chem. Phys., 50: 5229-31(June 15, 1969).

A calculation is presented of the effect of triple-dipole forces on the differences of volume of ^{20}Ne and ^{22}Ne lattices of 0°K in the quasiharmonic approximation. (auth)

35092 RAMAN DIFFUSION AND INFRARED ABSORPTION SPECTRA OF N-DIDEUTERATED LIQUID AND SOLID ETHYLENIMINE: COMPARISON WITH THE SPECTRA OF NORMAL ETHYLENIMINE. Le Brumant, Jacques (Faculte des Sciences, Paris). Compt. Rend., Ser. B, 268: 1424-7(June 2, 1969). (In French).

The Raman diffusion spectra (3,400 to 50 cm^{-1}) and the infrared absorption spectra (4,000 to 400 cm^{-1}) of $(CH_2)_2ND$ as well as the Raman spectra of $(CH_2)_2NH$ were determined at 293 and 80°K. Several bands are shown, particularly those relative to ν_{ND} and ν_{NH}. (tr-auth)

35093 DEUTERIUM EXCHANGE OF VERATROLE, BENZO-1,4-DIOXANE, AND BENZO-1,3-DIOXOLE WITH TRIFLUOROACETIC ACID. Serebryanskaya, A. I.; El'tsov, A. V.; Shatenshtein, A. I. (Karpov Physicochemical Inst., Moscow). Zh. Org. Khim., 3: 358-65(Feb. 1967). (In Russian).

Hydrogen–deuterium exchange in veratrole, benzo-1,4-dioxane, benzo-1,3-dioxole, and their symmetrical dimethyl derivatives with trifluoroacetic acid was studied. To obtain additional evidence on the reactivity of the ortho positions, the kinetics of H–D exchange of 1,2-dimethyl-4,5-dimethoxybenzene, 6-7-dimethylbenzo-1,4-dioxane, and of 5,6-dimethylbenzo-1,3-dioxole with CF_3COOD was measured. Average values for the deuteration rate constant for compounds are tabulated. The practically identical rate constants for exchange in the para position with respect to the oxygen atoms in veratrole and benzo-1,4-dioxane indicated proximity of the values of π-electron densities in these sites in the molecules, since the steric hindrances and structure of the transition state are approximately identical when the same electrophilic reagent is employed. Measurements conducted on the last 3 compounds mentioned above gave the following average values of rate constants, $k^{25°} \times 10^4$ in sec^{-1}: 1.3 (±0.1), 2.5 (±0.2), and 0.28 (±0.01). Thus, reactivity in the ortho positions with respect to the oxygen atoms in veratrole was lower than in benzo-1,4-dioxane if it is assumed that the introduction of 2 methyl groups is not reflected in the relative reactivity of the ortho positions. The indicated order may be explained by steric hindrance. (BBB)

35094 MEASUREMENTS OF DEUTERIUM QUADRUPOLE COUPLING IN FORMIC ACID. Kukolich, Stephen G. (Univ. of Illinois, Urbana). J. Chem. Phys., 51: 358-60(July 1, 1969).

The $1_{01}-0_{00}$ rotational transition was observed in HCOOH, HCOOD, and DCOOH using a maser spectrometer. Quadrupole hyperfine structure was completely resolved in HCOOD and DCOOH. The measured quadrupole coupling strength along the OD-bond direction was eqQ = 391 kHz and HCOOD and eqQ = 249 kHz along the DC-bond direction in DCOOH. These coupling constants and the deuterium quadrupole coupling in NH_2D are compared with the corresponding force constants and the results are in fairly good agreement with the theory of Salem. (auth)

35095 EFFECT OF DEUTERATION ON THE FLUORESCENT LIFETIME OF LIQUID BENZENE. Helman, W. P. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 51: 354-7(July 1, 1969). (COO-38-646).

Decay times of neat benzene C_6H_6 and C_6D_6 fluorescence excited by 250-nm light are, respectively, 27 and 32 nsec at 25°C. Measurements made over the range of temperature from 5° to 35°C for both of the pure benzenes and of solutions in cyclohexanes C_6H_{12} and C_6D_{12} show that the solvent is without effect on the measured rates, that at a particular temperature benzene monomer

and excimer have the same rate of de-excitation (corresponding to lifetimes of 28 nsec for C_6H_6 at 25°C and 33 nsec for C_6D_6 at 22°C), and that the activation energy for internal conversion of monomer in both cases (on certain stipulated assumptions) is 0.28 eV within limits of experimental error. The reduction, by deuterium substitution, in the rate of de-excitation from the monomer is less than the reduction in the rate from excimer and the rate for benzene excimer is indicated to be independent of temperature in the range studied. (auth)

35096 ELECTRONIC ABSORPTION SPECTRA OF MATRIX-ISOLATED URANIUM TETRACHLORIDE AND URANIUM TETRABROMIDE MOLECULES. Clifton, J. R.; Gruen, D. M.; Ron, A. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 224-32 (July 1, 1969).

The electronic absorption spectra of UCl_4 and UBr_4 molecules isolated in nitrogen matrices cooled to liquid-helium temperatures were observed and measured in the range 400 to 50,000 cm^{-1}. The more than 30 narrow absorption bands, found in the 4000 to 24,000-cm^{-1} region for each of the two molecules, were assigned to pure electronic transitions from the $^3H_4(\Gamma_2)$ ground state to excited states of the f^2 configuration. Energy-level calculations were performed by simultaneously diagonalizing the electrostatic, the spin-orbit coupling, and the (tetrahedral) crystal-field interactions. The crystal-field parameters of fourth and sixth degree, designated as A $\langle r^4 \rangle$ and B $\langle r^6 \rangle$, were found to be −593 and −22 cm^{-1} for UCl_4 and −490 and −15 cm^{-1} for UBr_4. These values of the parameters were obtained by a least-squares fit of observed-to-calculated energy levels allowing A $\langle r^4 \rangle$ and B $\langle r^6 \rangle$ to vary while maintaining the values of F_2, F_4, F_6, and ζ_{5f} at 191, 34, 4, and 1796 cm^{-1}, respectively. The magnitudes of A $\langle r^4 \rangle$ and B $\langle r^6 \rangle$ calculated on the basis of a point-charge model including induced dipole contributions were found to be −345 and 26 cm^{-1} for UCl_4 and −309 and 22 cm^{-1} for UBr_4. (auth)

35097 STRUCTURE OF ADSORBED NITRATE IN THORIA SOLS AND GELS. Whateley, T. L. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). J. Inorg. Nucl. Chem., 31: 2015-19(July 1969).

The structure of the adsorbed nitrate group in thoria sols and gels was studied by ir spectroscopy. Spectra are interpreted as showing that in sols nitrate is adsorbed as the nitrate ion and in gels as a unidentate nitrate surface group. With further loss of water, on heating in a vacuum, transition to a bidentate nitrate structure occurs. Desorption of nitrate is complete in a vacuum at 400°C; a residual adsorbed unidentate carbonate species remains. (auth) (UK)

35098 SOLVENT EXTRACTION OF CHROMIUM(III), MOLYBDENUM(VI), AND TUNGSTEN(VI) WITH THENOYLTRIFLUOROACETONE. De, Anil K.; Sahu, Chittaranjan (Dept. of Chemistry, Santiniketan, India). J. Inorg. Nucl. Chem., 31: 2257-65(July 1969).

The nature and composition of the metal-TTA complexes (M = Cr, Mo, W) were investigated by spectrophotometric methods applicable to a maximum concentration of 1.9×10^{-5}M chromium, 4.16×10^{-6}M molybdenum, and 4.33×10^{-6}M tungsten. Chromium forms CrT_3 and $CrT_2(OH)(H_2O)$, or CrT_3 and $CrT(SO_4)_2^-$ at pH3 – 5.5 or pH > 5.7, 1.0M hydrochloric acid or 0.5M sulphuric acid, respectively. Molybdenum and tungsten form MO_2T_2 type complexes at 6.0 and 5.6M hydrochloric acid, respectively, while at 0.05M sulphuric acid they form HMO_2T_3 type complexes. The extraction constants of these species were calculated. The distribution ratio of TTA under various conditions was determined. (auth) (UK)

35099 KINETIC ISOTOPE EFFECTS IN THE THERMAL CRACKING OF NEOPENTANE. Frank, D. J.; Sackett, W. M. (Texas A and M Univ., College Station). Geochim. Cosmochim. Acta, 33: 811-20(July 1969).

The isotope fractionation in relation to the cracking temperature and chain-reaction mechanism of the thermal decomposition of hydrocarbons was studied using 2,2-dimethylpropane (neopentane). The ^{13}C depletion in methane generated during thermal cracking was found to be 18.7, 18.1, 18.0, and 17.7 ± 0.2‰ at 500, 525, 550, and 600°C, respectively, showing that the temperature dependence of the kinetic isotope effect (~1.0‰ from 500 to 600°C) was relatively unimportant. This and previous studies suggest that the multiplicity of carbon–carbon bond types available for breaking and isotope fractionation associated with the cracking of decomposition products of the original hydrocarbon are the primary factors that determine the isotopic composition of the methane produced. (auth) (UK)

35100 KINETIC STUDIES ON ISOTOPIC EXCHANGE BETWEEN LUTETIUM ION AND ITS ETHYLENEDIAMINETETRAACETATE. Asano, T.; Okada, S.; Sakamoto, K.; Taniguchi, S.; Kobayashi, Y. (Radiation Center of Osaka Prefecture). J. Inorg. Nucl. Chem., 31: 2127-33(July 1969).

The thermal exchange reaction between lutetium ion and its EDTA complex in aqueous solution was studied in a pH range of 4.0 to 6.0 and concentrations of lutetium ion and complex of the order of 10^{-3} to 10^{-4}M. The rate was found to be proportional to $[H^+]^{1.0 \text{ to } 1.5}$ and $[LuY]^{1.0}$, and to be influenced slightly by the concentration of lutetium ion. Slight dependence on ionic strength was also observed in an ionic strength range of 0.02 to 0.2. Apparent activation energies 10.2 kcal $mole^{-1}$ and 11.6 kcal $mole^{-1}$ were obtained at pH 5.8 and 4.5, respectively. The rate of exchange at a pH value higher than 4.0 is expressed by: R mole $l.^{-1}$ $min^{-1} = k_1[LuY][H^+] + k_2'[LuY][H^+]^2 + k_4'[LuY][H^+]^3 + k_5[LuY][Lu^{3+}] + k_6'[LuY][H^+][Lu^{3+}]$ where k_1, k_2', k_4', k_5, and k_6' are 14 l $mole^{-1}$ min^{-1}, 1.5×10^6 l^2 $mole^{-2}$ min^{-1}, 4.2×10^{10} l^3 $mole^{-3}$ min^{-1}, 2.2×10^{-2} l $mole^{-1}$ min^{-1}, and 7.5×10^3 l^2 $mole^{-2}$ min^{-1} at 25°C in 0.01 M ammonium acetate buffer solution. Under the conditions studied the reaction via the protonation process is predominant and the bimolecular collision process is minor. Spontaneous dissociation processes can be ignored. (auth) (UK)

35101 INFRARED SPECTRA OF INORGANIC NITRATES IN ACETONE SOLUTION. Norwitz, G.; Chasan, D. E. (Frankford Arsenal, Philadelphia). J. Inorg. Nucl. Chem., 31: 2267-70 (July 1969).

The ir spectra of inorganic nitrates in acetone solution included studies on: $LiNO_3$, $Mg(NO_3)_2 \cdot 6H_2O$, $Ca(NO_3)_2$, $Ca(NO_3)_2 \cdot 4H_2O$, $Mn(NO_3)_2 \cdot xH_2O$, $Cd(NO_3)_2 \cdot 4H_2O$, $La(NO_3)_3 \cdot 3H_2O$, $Ce(NO_3)_3 \cdot 6H_2O$, $(NH_4)_2Ce(NO_3)_6$, $Zn(NO_3)_2 \cdot 6H_2O$, $Ni(NO_3)_2 \cdot 6H_2O$, $Cu(NO_3)_2 \cdot 3H_2O$, $Co(NO_3)_2 \cdot 6H_2O$, $Y(NO_3)_3 \cdot 4H_2O$, $Th(NO_3)_4 \cdot 4H_2O$, $UO_2(NO_3)_2 \cdot 6H_2O$, and $ZrO(NO_3)_2 \cdot 4H_2O$. Acetone has an advantage over TBP, TOPO solution in CCl_4, and trioctylamine nitrate solution in benzene, in that it permits the viewing of the N–O stretch of nitrates that occurs at approximately 1030 cm^{-1}. Data on the position, nature, and intensity of the nitrate peaks for the various inorganic nitrates in acetone are tabulated. The observed frequencies fall into the following ranges: 730 to 763, 804 to 827, 1003 to 1042, 1278 to 1325, and 1455 to 1527 cm^{-1}. In a few cases more than one peak was observed due to splitting. (P.C.H.)

35102 A STUDY OF THE MECHANISM OF WATER TRANSFER ACROSS FROG SKIN BY A COMPARISON OF THE PERMEABILITY OF THE SKIN TO DEUTERATED AND TRITIATED WATER. King, Venetia (Chelsea Coll., London). J. Physiol. (London), 200: 529-38(Feb. 1969).

The possibility of existence of an isotope effect was evaluated in a study of the movement of D_2O and T_2O in the frog (Rana temporaria). It was expected that if water transfer across a membrane occurs by exchange of external water with the water of hydration of the membrane components, and the making or breaking of oxygen–hydrogen (O–H) bonds is a rate-limiting step in the process, a primary kinetic isotope effect might be observable if the rates of two hydrogen isotopes were compared. Abdominal skin was placed between the 2 half-cells of a modified version of Ussing's frog skin apparatus. The rate of equilibration of deuterated and tritiated water across the skin was followed at pH 5.0, 6.9, and 8.0 with Ringer solution bathing both surfaces of the skin; and at pH 7.0 with sulfate-Ringer solution bathing both surfaces of the skin. The ratio of the permeability coefficients for the influx of deuterated and tritiated water had a mean value over all the experiments of 0.9954 ± 0.0207, indicating that no isotope effect was observable within the limits of accuracy of the method used. The thickness of the unstirred layers associated with the frog skin was measured, and, from the data obtained, values of the true permeability coefficients for each isotope were calculated. (BBB)

35103 VARIATIONS IN THE RELATIVE STABILITIES OF THE DI-, TRI-, AND TETRA-POSITIVE OXIDATION STATES OF THE LANTHANIDES AND ACTINIDES. Johnson, D. A. (University Chemical Lab., Cambridge, Eng.). J. Chem. Soc., A, No. 10, 1528-30(1969).

Evidence is presented to suggest that the variations in the ease of interconversion of the di- and tri-positive, and tri- and tetra-positive oxidation states of the lanthanides and actinides may be correlated with the anticipated variation in the corresponding ionization potentials. (auth) (UK)

35104 A URANYL PERRHENATE: $(UO_2)(ReO_4)_2$. Silvestre, Jean-Paul; Freundlich, William (Faculte des Sciences, Paris). Compt. Rend., Ser. C, 268: 2098-2101(June 16, 1969). (In French).

Evidence is presented for a uranyl perrhenate, $(UO_2)(ReO_4)_2$, obtained either by the action of the vapor of the oxide Re_2O_7 on the oxide UO_3 at 700°C in a sealed tube or by the action of perrhenic acid on the oxide UO_3 in aqueous medium. Two hydrates were identified with 1 and 1.5 moles of H_2O, respectively. (tr-auth)

35105 ADVANCED CHEMISTRY OF RARE ELEMENTS. Prakash, Satya. New York, Chemical Publishing Company, Inc., 1967. 814p. $16.50.

The lesser known elements of each chemical group are separated and discussed. The various theories of chemical bonding are considered. (M.C.G.)

35106 MOLECULAR IONS IN THE MASS SPECTRA OF THORIUM BY HIGH-FREQUENCY SPARKS. Vidal, G.; Galmard, P.; Lanusse, P. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux, France). J. Mass Spectrom. Ion Phys., 2: 405-7(May 1969). (In French).

In high frequency mass spectrometry, the mass spectrum of even a very pure metal often reveals supplementary rays that correspond to molecular ions formed by the association of the metal with hydrogen, carbon, nitrogen, and oxygen. The presence of ThH^+, ThH_2^+, and ThH_3^+ molecular ions in Th was confirmed. The rays of ThO^+ and ThO_2^+ were very intense. ThO^{2+} and $ThOH_3^{+}$ were also detected, while the ThC^+ and ThC_2^+ rays were very sharp. The existence of nitrides was only hypothetical and was not confirmed. (J.S.R.)

35107 LATTICE VIBRATION SPECTRA OF $Sr(OD)_2 \cdot D_2O$ AND $Ba(OD)_2 \cdot D_2O$. Lutz, H. D.; Heider, R. (Univ., Cologne). Z. Naturforsch., 24a: 476-7(Mar. 1969). (In German).

The lattice vibration spectra of $Sr(OD)_2 \cdot D_2O$ and $Ba(OD)_2 \cdot D_2O$ as well as partially deuterated compounds were investigated. Rotational and translational vibrations were studied and data are given in a table and graph. (M.C.G.)

35108 ISOTOPE EFFECTS IN REACTIONS OF BENZENE WITH TRITIUM IONS. Kuklin, Yu. S.; Firsova, L. P.; Chernik, V. (Moscow State Univ.). Khim. Vys. Energ., 3: 185-6(Mar.-Apr. 1969). (In Russian).

Studies were made on the isotope effects in the process of tritium labeling of products by the reaction of benzene with tritium ions T^+. The ion beams of energy in the range of 0.5 to 2.5 keV were formed in an ion separator. Data on the analysis of irradiated hexadeuteriobenzene in comparison with normal benzene are tabulated. The results showed that the isotope effects are different from the processes of H and D substitution. This difference appears not only in the quantity of the isotope effects, but also in the mechanism of the isotopic substitution in the benzene molecule. For example, in the process of labeling the basis substances $k_H/k_D = 1.21 \pm 0.05$ and for the reactions of tritium addition to the benzene ring with the formation of cyclohexene and cyclohexadienes $k_H/k_D < 1$. The results illustrate the role played by specific isotope effects of slowing down at various initial energies of bombarding T^+ ions. For C_6H_5D the isotope effects of substitution reactions were equal to 1.10 and for the reaction of tritium addition involving a double bond no isotope effects were observed. (tr-auth)

35109 CHEMICAL STATE OF FISSION TELLURIUM RELEASED FROM IRRADIATED UO_2 AND UO_2–GRAPHITE MIXTURES. Shiba, Koreyuki (Japan Atomic Energy Research Inst., Tokai); Hanada, Muneo; Yajima, Seishi. J. Nucl. Sci. Technol. (Tokyo), 6: 333-7(June 1969).

The chemical state of fission Te released from ceramic fuels was studied by means of the thermochromatograph. In inert atmosphere, the fission Te was found to be released in the form of metal, but in the presence of oxygen, it readily reacted therewith to form TeO_2. The chemical state of I released from Te and TeO_2 was also determined. (auth)

35110 TEN-CO-ORDINATE THORIUM: THE CRYSTAL STRUCTURE OF POTASSIUM THORIUM TETROXALATE TETRAHYDRATE. Akhtar, M. N.; Smith, A. J. (Univ. of Sheffield, Eng.). J. Chem. Soc., D, No. 13, 705-6(1969).

The thorium atoms in $K_4Th(C_2O_4)_4 \cdot 4H_2O$ are each surrounded by ten oxygens at the vertices of a bicapped square antiprism; this coordination number is achieved by oxalate bridging, the resulting chains being crosslinked by hydrogen bonding. (auth) (UK)

35111 SOLVENT ISOTOPE EFFECT ON HYDROLYSIS OF TERTIARY BUTYL CHLORIDE. Albery, W. J.; Robinson, B. H. (Physical Chemistry Lab., Oxford). Trans. Faraday Soc., 65: 1623-9(June 1969).

Accurate values of the solvent isotope effect for the solvolysis of tertiary butyl chloride as a function of deuterium content and temperature were obtained by the differential method. The results are not consistent with a simple one-step SN_1 mechanism; however, these results, and the deviations from the Arrhenius equation that the reaction exhibits can be explained by a mechanism involving an intermediate. The nature of the intermediate is discussed. (auth) (UK)

35112 METHOD OF MELTING NUCLEAR FUEL OXIDES. (to EURATOM). French Patent 1,428,864. Filed Mar. 23, 1965.

A method of melting a nuclear fuel oxide, e.g., UO_2, PuO_2, or a mixture of these, comprises compacting the powdered oxide to form briquets, stacking the briquets in a column in a water-cooled graphite crucible having a diameter that exceeds the diameter of the column, heating the briquets in an inert gas, e.g., Ar, to red-heat by passing an alternating electric current through the column between the bottom of the crucible and a graphite electrode contacting the upper briquet, filling the annular space between the column and the crucible with powder of the oxide, which acts as a thermal insulator, and finally increasing the current density until the briquets start to melt. The graphite electrode is lowered as the melting proceeds. (NPO)

35113 POLAROGRAPHY OF URANIUM(VI) COMPLEXES WITH N-HYDROXYETHYL–ETHYLENEDIAMINE–TRIACETIC ACID. Lai, Tsai-teh; Lee, Shi-tsuen (Chen Kung Univ., Tainan, Taiwan). Anal. Chem., 41: 1316-19(Aug. 1969).

The polarographic behavior, formation constants, and distribution ratio of chelates formed between uranium(IV) and HEDTA (N-(hydroxyethyl)-ethylenediaminetriacetic acid) are reported. It is shown that the electrode reactions are one-electron reversible and diffusion-controlled processes. (M.C.G.)

35114 MECHANISMS IN COPRECIPITATION OF BERKELIUM(IV) WITH CERIUM(IV) IODATE FROM HOMOGENEOUS SOLUTION. Fardy, John J.; Weaver, Boyd (Oak Ridge National Lab., Tenn.). Anal. Chem., 41: 1299-1302(Aug. 1969).

Ce(III) in HNO_3 containing iodate is homogeneously oxidized by bromate to Ce(IV), which is precipitated as $Ce(IO_3)_4$ with a second-order rate relation. Precipitation occurs at room temperature, and the rate increases with concentrations of bromate and iodate, but decreases as concentration of acid increases. Bk(III) is oxidized and coprecipitated with Ce(IV). Under conditions where precipitation is not too rapid, concentrations of the two elements in solution decrease with precipitation according to the equation $\log [(\Sigma Bk)_i/(\Sigma Bk)_f] = k\lambda \log [(\Sigma Ce)_i/(\Sigma Ce)_f]$ where $k = [(Bk^{4+})/(Bk^{3+})]/[(Ce^{4+})/(Ce^{3+})]$ and has a value of ~10, and $k\lambda$ is nearly 3. (auth)

35115 SECONDARY DEUTERIUM ISOTOPE EFFECTS IN THE COPE REARRANGEMENT. Humski, K.; Strelkov, T.; Borcic, S.; Sunko, D. E. (Rudjer Boskovic Inst., Zagreb). J. Chem. Soc., D, No. 13, 693-4(1969).

Kinetic secondary deuterium isotope effects observed during the thermal rearrangement of [6,6-$^2H_2$]-3,3-dicyano-2-ethyl-1-methylhexa-1,5-diene and the [4,4-$^2H_2$]-labeled compound are described. The rearrangements were performed in n-decane solution at 85°C and rates were followed by measuring the increase in the absorption at 238 nm due to the product formed. The rates were followed simultaneously for deuterated and undeuterated compounds. The results of kinetic measurements are tabulated. (auth) (UK)

35116 A METHOD FOR PURIFYING CARBON DIOXIDE GAS. Dirian, Gregoire; Dolle, Lucien; Zermizoglou, Roger (to Commissariat a l'Energie Atomique). British Patent 1,156,368. June 25, 1969. Priority date Dec. 30, 1965, France.

Methane was added to CO_2 used as coolant in a gas-cooled reactor to prevent corrosion of the graphite. However, the addition of methane results in the production of H_2, H_2O, and CO, which must be eliminated. The H_2O is converted into H_2 by the reaction with CO at a temperature of 170 to 200°C in the presence of a low-temperature water gas conversion catalyst. The H_2 is then eliminated by diffusion through tubes made of a Pd-base alloy. The CO is oxidized to CO_2 in the presence of a Pt, Pd, Cu, or CuO catalyst. (B.L.M.)

35117 HEATS OF DILUTION OF SOME ALKALI METAL HALIDES IN DEUTERIUM OXIDE AND WATER. Wood, R. H.; Rooney, R. A.; Braddock, J. N. (Univ. of Delaware, Newark). J. Phys. Chem., 73: 1673-8(June 1969).

The heats of dilution of lithium chloride, sodium chloride, sodium bromide, and potassium chloride in H_2O and D_2O were measured at 3, 2, and 1 m at 25°C. The results were fit to the equation $\phi_L^{H_2O} - \phi_L^{D_2O} = k_1 m' + k_2 m'^{1/2}$. Excess entropies, S^{ex}, were calculated from the heats of dilution and the free energy data of Frank and Kerwin. The excess entropies show that all of these salts are more structure breaking in D_2O than they are in H_2O. This confirms the conclusions of Greyson and Kay and Evans. The results are related to current theories. (auth)

35118 THE KINETICS OF THE REACTION BETWEEN VANADIUM(II) AND NEPTUNIUM(V) IN AQUEOUS PERCHLORATE SOLUTIONS. Burkhart, Mary J.; Newton, T. W. (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 73: 1741-6(June 1969).

The reaction Np(IV) + V(II) = Np(III) + V(III) was studied in acid perchlorate solutions from 0.016 to 2.0 M $HClO_4$, from 0.9 to 36.7°C at an ionic strength of 2.0 M ($LiClO_4$). The rate law at 25°C is $-d[Np(IV)]/dt = \{2.53 + (3.8 \times 10^{-2}/[H^+])\} + (6 \times 10^{-4}/[H^+]^2)\}[Np^{4+}][V^{2+}]$. The temperature dependence of the predominant, hydrogen ion independent term leads to $\Delta H^* = 9.72 \pm 0.05$ kcal/mol and $\Delta S^* = -24.0 \pm 0.2$ cal/mol deg for $Np^{4+} + V^{2+}$ = activated complex. Chloride ion causes a moderate increase in rate. For the most important chloride term the net activation process is $Np^{4+} + V^{2+} + Cl^-$ = activated complex, for which $\Delta H^* = 13.45 \pm 0.15$ kcal/mol and $\Delta S^* = -5.5 \pm 0.4$ cal/mol deg. The effect of ionic strength is in accord with an extended form of the Debye–Hückel equation from 0.275 to 4.0 M. The hydrogen ion, chloride ion, and temperature-dependence data are consistent with an outer-sphere mechanism. (auth)

35119 THE REVERSIBLE HYDRATION OF 2- AND 4-PYRIDINECARBOXALDEHYDES. III. SOLVENT DEUTERIUM ISOTOPE EFFECTS. Pocker, Y.; Meany, J. E. (Univ. of Washington, Seattle). J. Phys. Chem., 73: 1857-61(June 1969).

The solvent deuterium isotope effects associated with the general acid, general base catalyzed hydrations of 2- and 4-pyridinecarboxaldehydes in veronal, phosphate, and acetate buffers were determined. The kinetics for these reactions in both H_2O and D_2O were followed at 0.0°C using a spectrophotometric method from which ratios of k_H/k_D were deduced for the spontaneous reaction, for hydronium and hydroxide ions as well as for the general acid–base components of the buffers employed. The data show that for the hydration of 4-pyridinecarboxaldehyde the kinetic deuterium isotope effects are 4.2 for water, 2.9 for acetate ion, 2.6 for acetic acid, 2.2 for monohydrogen phosphate, 1.3 for hydronium ion, and 0.9 for hydroxide ion. The deuterium isotope effects associated with the hydration of 2-pyridinecarboxaldehyde were generally found to be about 25% lower. The effects are compared with similar data pertaining to the mutarotation of glucose and the hydration of acetaldehyde. (auth)

35120 A KINETIC STUDY OF ORTHOPHOSPHATE SORPTION ON METAL OXIDES. Vissers, D. R. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 73: 1953-5(June 1969).

The kinetics of phosphate sorption on thorium and zirconium oxides are described by a rate equation which contains both a linear surface site depletion term and a term in which the fraction of surface coverage occurs exponentially. This is interpreted to mean that the activation energy increases linearly with the quantity of phosphate sorbed. The activation energy for the phosphate sorption on crystalline thorium oxide at zero phosphate coverage was found to be 3.0 ± 0.3 kcal mol^{-1}; the sorption process thus is very probably solution diffusion controlled. (auth)

35121 REDUCTION OF NIOBIUM PENTOXIDE WITH MAGNESIUM. Baba, Riichi; Imagawa, Koji (Resources Research Inst., Saitama, Japan). Nippon Kogyo Kaishi, 85: 351-6(May 1969). (In Japanese).

Niobium pentoxide precipitated from aqueous solution and calcined at 780°C was reduced with Mg. The reduction generally occurred at 600 to 650°C, but the addition of $KClO_4$ or $KClO_3$ lowered the reaction temperature. However, the initiation of the reaction induced a rapid elevation of temperature even with $KClO_4$ present. The reaction was carried out in a closed vessel with massive metal being produced. A cold reduction of over 95% was possible without intermediate annealing after nonconsumable arc melting and electron-beam melting. (NSA of Japan)

35122 COMPLEXES OF URANYL DIKETONES WITH AROMATIC SULPHOXIDES. Subramanian, M. S.; Viswanatha, A. (Bhabha Atomic Research Centre, Trombay, India). J. Inorg. Nucl. Chem., 31: 2575-85(Aug. 1969).

The use of sulphoxides as synergists in the solvent extraction of uranyl ion with β-diketones was investigated by distribution measurements in the system UO_2^{2+}/HTTA/S, where S is diphenyl or dibenzyl sulphoxide. Results indicate that the sulphoxides exert only a feeble synergetic action, which is several orders of magnitude smaller than that of trioctyl phosphine oxide. Values of the equilibrium constants for the system UO_2^{2+}/HTTA/S are comparable in magnitude to those of the analogous systems with tributyl phosphate. Solid crystalline complexes of the formula UO_2X_2S (X = anion of thenoyltrifluoroacetone, acetylacetone or dibenzoylmethane) were isolated. Infrared and proton nuclear magnetic resonance spectra indicate that both the β-diketone moieties in these systems are bidentate. ^{19}F nuclear magnetic resonance spectra, however, do indicate some disymmetry in the molecules $UO_2(TTA)_2TOPO$ (TOPO = trioctyl phosphine oxide) and $UO_2(TTA)_2DBSO$ (DBSO = dibenzyl sulphoxide). This disymmetry is probably caused by the incorporation of the neutral donor molecule into the complex. (auth) (UK)

35123 ELECTROMETRIC STUDIES ON THORIUM ARSENATES AS A FUNCTION OF pH. Saxena, R. S.; Prasad, Shiva (Malaviya Regional Engineering Coll., Jaipur, India). Z. Naturforsch., 24b: 795-9(July 1969).

The formation and composition of thorium arsenates obtained by the interaction of thorium nitrate and different sodium arsenates (meta, pyro, and ortho) at specific pH levels, 7.2, 8.3, and 11.1, were studied by employing electrometric techniques involving amperometric, pH, potentiometric, and conductometric titrations. The results provide cogent evidence for the formation of three thorium arsenates having the molecular formulas $ThO_2 \cdot 2\,As_2O_5$, $ThO_2 \cdot As_2O_5$, and $3\,ThO_2 \cdot 2\,As_2O_5$ in the vicinity of pH 4.2, 4.9, and 5.6, respectively. Analytical investigations of the compounds were also carried out, which substantiate the results of electrometric study. (auth)

35124 ASSOCIATION-DISSOCIATION EQUILIBRIA AND THE STRUCTURE OF URANYL CHLORIDE IN ORGANIC SOLVENTS. Ernst, S.; Jezowska-Trzebiatowska, B. (Wroclaw Univ.). J. Inorg. Nucl. Chem., 31: 2505-14(Aug. 1969).

The conductances of solutions of uranyl chloride monohydrate, of anhydrous uranyl chloride and of complexes of uranyl chloride with quinoline N-oxides in methanol, ethanol, n-propanol, n-pentanol and acetone were measured. Measurements at 15, 25, and 35°C were analysed by the Shedlovsky, Fuoss-Kraus, Wooster and Fuoss–Edelson methods. The limiting conductances, Λ_0, association constants, K_A, and triplet formation constants, k_A, are reported, together with free energies of association, $\Delta G°$, free energies of triplet formation, $\Delta g°$, ion-size parameters, a_B, average enthalpies of association, $\Delta H°$, and entropies of association, $\Delta S°$. The values obtained show the less covalent character of the cation-anion bond in comparison with uranyl nitrate. (auth) (UK)

35125 MECHANISM OF DEPOSITION OF CARRIER-FREE ^{32}P ON PREFORMED IONIC SOLIDS. Kar, K. R. (Univ. of Delhi); Bhutani, M. M. J. Inorg. Nucl. Chem., 31: 2303-9 (Aug. 1969).

A mechanism is suggested for carrying of ^{32}P (as orthophosphate in the carrier-free state) by preformed $BaSO_4$, $SrSO_4$, and $PbSO_4$ in ignited or freshly prepared states. It is postulated that, under the specified experimental conditions, the tracer phosphate is deposited superficially by the mechanism of counter ion exchange on such microcrystalline solids as $Pb(H_2PO_4)_2$, $BaHPO_4$, and $SrHPO_4$. While deposition takes place mainly on the exposed surface of the ignited carrier, the tracer is considered to be mainly entrapped internally in the canals and capillaries present in the freshly formed precipitates. (auth) (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 35032, 35048, 35258, 35262, 35562, 35651, 35654, 36817, and 37493.

35126 (AERE-R-6090) THE RADIATION POLYMERISATION OF IMPREGNATED FIBROUS MATERIALS: RECENT DEVELOPMENTS IN THE UNITED KINGDOM. Hills, P. R.; Barrett, R. L.; Pateman, R. J. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). May 1969. 40p. Dep. CFSTI UK 6s. 0d.

The novel properties conferred on timber by impregnation with monomers that are subsequently polymerized by radiation, encouraged the establishment of a wood-processing service by the United Kingdom Atomic Energy Authority. The development of this project is described, with particular reference to its first application: moisture-resistant cutlery handles. The present extension of the process to other manufactured items and materials is discussed, together with some longer-term objectives. Other experiments designed to characterize the useful properties of wood-plastic composites derived from timbers commonly available in the United Kingdom are also reported. (auth) (UK)

35127 (BNL-13692) RADIATION CHEMICAL NITROGEN FIXATION IN AIR-WATER SYSTEMS. Sato, Shoichi; Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Mar. 1969. 24p. Dep. CFSTI.

Nitrogen fixation by ^{60}Co γ rays in an air–water system was studied under bubbling air conditions. Two main products, ammonium and nitrite were analyzed and yields were obtained with varying pH of the solution and flow rate of air. Ammonium was considered to be the primary product of fixation and nitrite mainly

the secondary product of the radiation oxidation of ammonium. Nitrate is subsequently formed by air oxidation of the nitrite. The study of the effect of pH showed that ammonium formation was favored by low pH but its oxidation to nitrite was favored by high pH. The G-values, calculated for the total amount of the dissolved and bubble air, for nitrite formation were 1.9 to 3.8 for 0.01 to 0.5 N NaOH and 0.6 to 1.0 for 0.01 to 0.5 N H_2SO_4 and for ammonium formation almost zero for NaOH solutions and 40 to 76 for the H_2SO_4 solutions. A study was made of the effect of air flow rate on the average bubble diameter. The G-values of ammonium and nitrite were for neutral water 5 to 14 and 1.4 to 1.6, based on the total amount of air in the system, depending on the flow rate, and were higher than the values for dissolved air which were 2.3 and 0.8, respectively. From the difference, G-values of nitrite were obtained based on the amount of air existing in the bubbles, which showed a similar trend proportional to the reciprocal of the bubble diameter. (auth)

35128 (BNWL-SA-1492) SIMULTANEOUS RECOVERY AND PURIFICATION OF Pm, Am, and Cm BY THE USE OF ALTERNATING DTPA AND NTA CATION-EXCHANGE FLOWSHEETS. Wheelwright, E. J.; Roberts, F. P.; Bray, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 6, 1968. Contract AT(45-1)-1830. 26p. (CONF-680308-17). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

Approximately 140 g of promethium, 50 g of ^{244}Cm, and 1000 g of a mixture of ^{241}Am and ^{243}Am were recovered from 13½ tons of Shippingport Reactor blanket elements and purified. After the fuels were treated by the Redox process, the waste solutions were subjected to a batch extraction using TBP to extract rare earths, americium, and curium. These elements were purified by extraction using the DEHPA–TPP process and then separated from one another by cation exchange using DTPA and NTA. (M.C.G.)

35129 (DP-1183) SEPARATION OF ^{171}Tm FROM IRRADIATED ENRICHED ERBIUM. Hale, William H. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1969. Contract AT(07-2)-1. 18p. Dep. CFSTI.

A chromatographic cation exchange process was developed to separate ^{171}Tm from irradiated enriched erbium. Thirty-eight mg of pure thulium were separated from a 1-gram sample of irradiated $^{170}Er_2O_3$. (auth)

35130 (DP-1194) ISOLATION OF ^{147}Pm BY RAPID CATION EXCHANGE CHROMATOGRAPHY. Lowe, J. T. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1969. Contract AT(07-2)-1. 29p. Dep. CFSTI.

A rapid cation exchange process was developed to separate ^{147}Pm from other fission product lanthanides by displacement development chromatography. Flow rates four times those used in conventional gravity-fed systems were achieved in pressurized columns containing small particle resin. (auth)

35131 (HMI-B-81) CALCULATION OF THE TIME BEHAVIOR OF THE RADIOACTIVITY AND RADIOACTIVITY CONCENTRATION DURING THE ELUTION OF RADIONUCLIDE GENERATORS. Gaus, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Apr. 1969. 11p. (In German). Dep.

The kinetics of a chromatographic column were calculated. The release from granulated substance is unhindered, there is no reabsorption, and the mixture of different layers from the liquid is negligible. If the half-life of the parent is longer than that of the daughter, the condition for maximum concentration of the outgoing liquid is as follows: the time for passing through the column must be longer compared with the reciprocal difference of the decay constants. The highest total amount, at any time point, is given by a similar condition. (auth)

35132 (NYO-1158-32) ANNUAL PROGRESS REPORT, JUNE 1, 1968–MAY 31, 1969. (Princeton Univ., N. J. Dept. of Chemistry). Contract AT(30-1)-1158. 7p. Dep. CFSTI.

Catalytic studies using molecular sieves and magnetic resonance work on these sieves are discussed. The problem of synthesizing gold and palladium particles of uniform size and alumina in the form of ultramacroscopic rods is being studied. The properties of methyl radicals trapped in 40 Å pores of Vycor silica are being investigated. Studies are being made of copper in Tutton salts, $K_2Zn(SO_4)_2 \cdot 2H_2O$, and oxygen confined in pores of Vycor glass. Iron ferrocene was prepared, supported on Vycor glass, and did not adsorb nitrogen. Wilkinson's triphenylphosphine rodium complex was prepared and its activity characterized. (M.C.G.)

35133 (NYO-3383-16) STUDIES ON PRIMARY PROCESSES IN THE RADIATION CHEMISTRY OF LIQUIDS AND ON THE MECHANISM OF THE INTERACTION OF RADIATION WITH BIOLOGICALLY IMPORTANT CHEMICAL SYSTEMS. Progress Report, May 8, 1968–June 1, 1969. Trumbore, Conrad N. (Delaware Univ., Newark. Dept. of Chemistry). Contract AT-(30-1)-3383. 19p. Dep. CFSTI.

Experimental evidence is cited that is said to challenge the "spur" model in aqueous radiation chemistry. The aqueous p-nitrosodimethylaniline (RNO) system is shown to exhibit several different kinds of anomalies in its radiation and photochemistry. Electron spin resonance studies are described, which indicate that OH radical attack on RNO is probably on the ring. A method is described for analyzing the radiolytic product dependence on concentration for binary systems. Computer calculations on pulse radiolysis data and mechanisms are described in which the importance is stressed of initial yields of H_3O^+ from the "spur" on hydrated electron decay. Unexpected pH values were calculated immediately after the pulse in pulse radiolysis or during the irradiation in steady-state radiolysis. Studies are also reported in which there was found an unusually wide variation in radiation sensitivity of various species of blue green algae. Some species are more radiation resistant than M. radiodurans. (auth)

35134 (NYO-3864-1) DEVELOPMENT OF A RADIOACTIVE PEBBLE BED CHEMICAL REACTOR SYSTEM. Phase II Report. Yang, J. Y.; Cullinan, H. T.; Thomas, C. C. Jr. (Western New York Nuclear Research Center, Inc., Buffalo). Feb. 14, 1969. Contract AT(30-1)-3864. 64p. Dep. CFSTI.

Detailed information regarding the reaction kinetics for the radiochemical production of benzotrichloride (α,α,α-trichlorotoluene) by the side-chain chlorination of toluene was obtained. At reaction temperatures greater than 80°C and pressures near one atmosphere, the rate of side-chain chlorination of toluene was found to be insensitive to limited temperature changes, but to show a square root dependence on radiation intensity and first order dependence with respect to the organic reactant concentration. With radiation dose rates in the range of 1×10^{20} to 7×10^{18} eV $mole^{-1}$ min^{-1}, the G-value for overall conversion to produce benzotrichloride varied from about 10^4 to 10^6. The fluidized bed expansion characteristics were studied by the use of 100 to 500 micron glass microspheres fluidized with toluene in two-inch and four-inch diameter columns. With the exception of a deviation in the region of incipient fluidization, the ratio of fluidized bed height to static bed height was found to be linearly dependent on the Reynold's number in a log-log plot, and the bed porosity, at static as well as fluidized conditions, was determined. The point source equation of Loevinger was used to establish the energy distribution from a $^{90}Sr-^{90}Y$ beta source, and an axial dispersed plug flow equation was used to incorporate both the kinetic and the fluidization factors. Based on an overall G-value of 10^5, the reactor operating parameters required for given production rates were determined. (P.C.H.)

35135 (ORO-2968-45) RADIATION-INDUCED ISOMERIZATION OF 1-BROMOBUTANE BY A FREE RADICAL CHAIN REACTION. Martin, Donald H.; Williams, Ffrancon (Tennessee Univ., Knoxville. Dept. of Chemistry). [nd]. Contract AT-(40-1)-2968. 27p. Dep. CFSTI.

It is shown that the radioinduced isomerization of 1-bromobutane to 2-bromobutane is an autocatalytic reaction in which hydrogen bromide functions as a chain transfer agent. The reaction was studied as a function of dose, dose rate, temperature, and added hydrogen bromide concentration. Free radical scavengers (DPPH and iodine) inhibit the chain reaction. The presence of hydrogen bromide is essential to chain propagation and experiments with tritiated HBr show that the tritium atom is transferred from TBr to give both 2-bromobutane and 1-bromobutane as radioactive products. In the absence of added hydrogen bromide, the concentration of butenes and HBr each attains a stationary value of ca. 5×10^{-4} M at very low doses. The butene products include cis- and trans-2-butene in addition to 1-butene. A mechanism is proposed whereby bromoalkyl radicals undergo rearrangement through steps that involve elimination of a bromine atom, olefin isomerization, and re-addition of $Br\cdot$. Kinetic analysis accounts for a limiting rate of isomerization at $[HBr] > 10^{-3}$ M, and leads to reasonable estimates for the rate constant ($4.4 \times 10^3 M^{-1}$ sec^{-1} at 30°) and the activation energy (8.5 kcal $mole^{-1}$) of the reaction, $Br\cdot + CH_3CH_2CH_2CH_2Br \rightarrow HBr + CH_3CH_2\dot{C}HCH_2BR$. (auth)

35136 (PRNC-128) MATRIX ISOLATION STUDIES OF THE GAMMA RADIOLYSIS OF HETEROCYCLIC MOLECULES. Progress Report No. 4. Grimison, A.; Simpson, G. A. (Puerto Rico Nuclear Center, Mayaguez). Apr. 1969. Contract AT(40-1)-1833. 88p. Dep. CFSTI.

Thermoluminescence of γ-irradiated adenine, cytosine, DNA, guanine, thymine, and uracil was studied. The ESR spectra of irradiated cytosine and uracil are also given. The luminescence of indole, indazole, purine, aniline, triphenylamine, and tetraphenylpyrrole was investigated in a study of photoionization of

heterocyclics. Excitation energies and valence bonds are being calculated for radical anions and cations of heterocyclic molecules. (M.C.G.)

35137 (PRNC-130) HOT-ATOM CHEMISTRY PROGRAM. Progress Summary Report 4, April 1968-April 1969. (Puerto Rico Nuclear Center, Mayaguez). Contract AT(40-1)-1833. 45p. Dep. CFSTI.

Studies are being made of the mechanism of Szilard-Chalmers processes in organic compounds. Metallocenes and metal carbonyls were used in the studies. The ^{125}Sb products formed in the neutron activation of phenyl tin compounds were identified. Recoil reactions in dicyclopentadienyl compounds as osmium and rhenium were studied. The radioactive products formed in the neutron activation of aromatic selenium and tellurium compounds were identified. Mechanisms were determined. Mechanisms of hot-atom reactions of aromatic phosphorus compounds in benzene solutions were investigated. (M.C.G.)

35138 (RRL-2310-276) QUARTERLY REPORT, APRIL 1-JUNE 30, 1969. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). July 3, 1969. Contract AT(30-1)-2310. 16p. Dep. CFSTI.

Progress is reported on electron reactions in the gas phase, electron scavenging in methanol and ethanol, transient solvated electron in pulse-irradiated viscous 1-propanol, positive ion scavenging in hydrocarbons, effect of scavengers on cyclohexane radiolysis, the rate of $CF_3^{\cdot}$ addition to C_2H_4 in liquid hydrocarbons, recombination rate constant for methyl radicals, further studies of $CF_3OO^{\cdot}$, ESR observations of H atoms in the radiolysis of water, and electron scavenging in irradiated viscous hydrocarbons. (M.C.G.)

35139 (TID-24923) THE RADIATION-INDUCED POLYMERIZATION AND COPOLYMERIZATION OF UNUSUAL MONOMERS. Stannett, V. T.; Turner, D. T.; Campbell, D.; Castille, Y. P.; Clark, H. G.; Cleveland, J. A.; Herz, J. E.; Kearney, J. J.; Lando, J. B. (Research Triangle Inst., Durham, N. C. Camille Dreyfus Lab.). Jan. 8, 1968. Contract AT(40-1)-2513. 145p. Dep. CFSTI.

Attempts to polymerize a large number of cyclopropane derivatives, nitriles, and allene, using high energy radiation under a variety of conditions (such as high and low temperatures in solution, in glassy and crystalline states, and in the presence of additives) yielded little or no polymers. Therefore, this phase of the program was abandoned in favor of more promising systems During a similar investigation of a number of ketones and ring compounds, two systems were developed and studied in depth. These were the radioinduced copolymerization of liquid formaldehyde with styrene and the polymerization of crystalline trithiane. The formaldehyde-styrene copolymers had considerably enhanced thermal stabilities, but were produced at low G-values. Among a number of other vinyl monomers studied, a few formed polyoxymethylenes of comparative thermal stabilities but at very high G values. However, infrared analysis failed to reveal any copolymer; thus it is questionable whether end-capping or copolymerization actually occurred. A detailed study was also conducted on the copolymerization and terpolymerization of sulfur dioxide with dienes and vinyl monomers. Good yields of polymers were obtained in many cases. Among the terpolymers synthesized, soluble and fusible polymers had reasonable thermal stabilities. Finally, a number of studies were conducted on the polymerization and copolymerization in the crystalline state. The crystallographic and other details of the polymerization of trithiane in the crystalline state were elucidated. However, attempts to polymerize or copolymerize analogues of trithiane were unsuccessful. A number of monomer pairs which polymerized in eutectic mixtures were discovered and studied. The β-propiolactone-styrene system, yielded a mixture of the two homopolymers; the acrylonitrile-β-propiolactone and the N-vinylcarbazole-N-phenylacrylamide systems formed essentially random copolymers. Speculations concerning the mechanism of copolymerization are also presented. (auth)

35140 THERMODYNAMIC INVESTIGATION OF THE SOLUBILITY OF GRAFTED COPOLYMERS OF TETRACHLOROETHYLENE WITH POLY(METHYL METHACRYLATE), OBTAINED BY RADIATION PROCESSES. Tashmukhamedov, S. A.; Usmanov, Kh. U.; Tillaev, R. S. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 12: 490-4(1969). (In Russian).

Thermodynamic investigations were made of the solubility of grafted copolymers of tetrachloroethylene with poly(methyl methacrylate), obtained by radiation processes, in relation to the radiation dose by which they were synthesized. The solubility, viscosity, and other properties of the copolymer were studied. (M.C.G.)

35141 RADIATION CHEMISTRY OF AQUEOUS SYSTEMS. Proceedings of the 19th L. Farkas Memorial Symposium Held at the Hebrew University of Jerusalem, Israel, 27-29 December, 1967. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968. 310p. $13.50. (CONF-671212).

Thirteen papers are included. One paper considers the history of radiation chemistry. Nine of the papers deal specifically with some aspect of radiolysis of liquids, particularly water and aqueous solutions. Three papers deal with aspects of radiation chemistry as related to radiobiology and radiotherapy. Separate abstracts were prepared for 11 of the papers. Two papers were previously abstracted for NSA. (B.L.M.)

For abstracts of individual papers see: 35142-35145, and 35153-35159.

35142 YESTERDAY AND TOMORROW IN RADIATION CHEMISTRY. Haissinsky, M. (Laboratoire Curie, Paris). pp 1-7 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

The following general aspects of radiation chemistry are discussed in some detail: fundamental radiolytic problems that still require an immense amount of work and directions that research might take. The discussion of research is limited to fundamental research in water and aqueous solutions. A brief discussion of radiobiology is also included. (B.L.M.)

35143 STUDY OF THE WATER MOLECULE IN THE GASEOUS PHASE EXCITED STATES OF H_2O, H_2O^+, AND H_2O^-. Fiquet-Fayard, F. (Faculte des Sciences, Orsay, France). pp 9-19 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

A short account of the electron configuration of water, including symmetry properties, is given. These simple considerations permit the explanation of the results of photoelectron spectroscopy experiments and photoionization experiments; the $^2B_2$ state of H_2O^+ is predissociated. Excited states of water are all repulsive or predissociated, the more important fragments being $OH^2\Pi$, $OH^2\Sigma^+$ and O. Some repulsive states of H_2O^- are known, but the important low-lying $^2A'$ state is unknown. (auth)

35144 COMMENTS ON THE STRUCTURE AND SPECTRA OF EXCESS ELECTRON STATES IN LIQUIDS. Jortner, J. (Tel-Aviv Univ., Israel). pp 91-107 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

The theory of excess electron states in nonpolar and polar fluids is critically examined. The results are applied to the special case of the hydrated electron, comparing available experimental results with the theory. (auth)

35145 ISOTOPICALLY SUBSTITUTED WATER IN THE INVESTIGATION OF THE PRIMARY RADIOLYTIC PROCESSES. Anbar, M. (Ames Research Center, Moffett Field, Calif.); Meyerstein, D. pp 109-55 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

The use of isotopes in the investigation of radiolytic processes is illustrated with a detailed discussion of the radiolytic processes in the three phases of water. Both tracer techniques and isotope effect studies are presented. Mechanisms of radiolysis that are consistent with experimental findings are discussed. A brief discussion of the photolytic behavior of water is also presented. (161 references). (B.L.M.)

35146 ENERGY TRANSFER AND RADIOLYTIC PRODUCT FORMATION IN THE SYSTEM POLYSTYRENE-PYRENE. Wilske, J.; Heusinger, H. (Technische Hochschule, Munich). J. Polym. Sci., Part A-1, 7: 995-1010(Apr. 1969).

The γ radiolysis of polystyrene at room temperature, the formation of radicals detected by ESR spectroscopy is greatly reduced in the presence of pyrene, while crosslinking and hydrogen production are almost unchanged. The formation of these radicals was shown to start from the first excited singlet state of polystyrene competing with radiationless energy transfer to pyrene. Crosslinking and hydrogen production, on the other hand, are independent of the formation of these radicals and attributable to hot hydrogen or ion-molecule reactions. Besides energy transfer from polystyrene to pyrene by dipole-dipole interaction the results indicate that intramolecular energy transfer within polystyrene is present. (auth)

35147 EFFECT OF NITROBENZENE IN THE STYRENE–CELLULOSE ACETATE GRAFT POLYMERIZATION SYSTEM. Hamburger, C. Joseph (Inst. of Paper Chemistry, Appleton, Wis.). J. Polym. Sci., Part A-1, 7: 1023-37(Apr. 1969).

The effect of nitrobenzene, a polymerization retarder, on the direct γ-induced graft polymerization of styrene onto pyridine-swollen cellulose acetate film was studied. When the films were not highly swollen, small nitrobenzene additions caused an increase in the amount of grafted polystyrene and grafted cellulose acetate. However, when the substrate was highly swollen, nitrobenzene additions reduced the amount of grafted polystyrene without pronounced changes in the amount of grafted cellulose acetate. The number-average molecular weights of the grafted side chains were always two to three times those of the homopolystyrene formed in the bulk monomer solution, which is indicative of hindered chain termination within the substrate film under all reaction conditions. Nitrobenzene additions prevented polystyrene crosslinking reactions, probably because the termination reactions in the presence of nitrobenzene occur by disproportionation rather than by coupling of chain ends. Viscometric results indicated that the polystyrene side chains were branched. (auth)

35148 POLYMERIZATION OF COORDINATED MONOMERS. I. STEREOREGULATION IN THE FREE-RADICAL POLYMERIZATION OF METHYL METHACRYLATE–ZINC CHLORIDE OR METHYL METHACRYLATE–STANNIC CHLORIDE COMPLEXES. Okuzawa, Shinjiro; Hirai, Hidefumi; Makishima, Shoji (Tokyo Univ.). J. Polym. Sci., Part A-1, 7: 1039-53(Apr. 1969).

Stereoregulation in free-radical polymerization was studied for polymerization of the 2:1 or 1:1 complex of methyl methacrylate with $ZnCl_2$ or $SnCl_4$. The complexes were polymerized with the use of a free-radical initiator or γ irradiation either in the liquid or solid state at various temperatures ranging from −196 to 110°C, and the tacticities of the resulting polymers were determined by NMR spectroscopy. The polymers had different and characteristic values of tacticities depending on the complex species, i.e., the kind of metal chloride and the stoichiometry. The tacticities were found to be independent of the polymerization temperature in both the liquid and solid states, in contrast with the fact that tacticities of the polymer from pure monomer changed markedly with the temperature. A temperature dependence appeared in the polymerization system, which contained more monomer than that corresponding to the 2:1 complex. The effect of the viscosity or the solid phase on the stereoregulation was examined in comparison with the polymerization of a mixture of methyl methacrylate and liquid paraffin. Two possible explanations regarding the stereoregulation mechanism are offered in relation to the structures of the complexes. (auth)

35149 ELECTRON SPIN RESONANCE STUDY OF RADIATION DEGRADATION OF POLYTETRAFLUOROETHYLENE. Hedvig, Peter (Research Inst. for Plastics, Budapest). J. Polym. Sci., Part A-1, 7: 1145-52(Apr. 1969).

Electron spin resonance measurements were performed at different stages of radiation degradation of polytetrafluoroethylene. It was found that under radiation, peroxy radicals were transformed into chain-end fluorocarbon radicals, which in turn became chain-side radicals. On the basis of these data, a scheme for the degradation mechanism is given. (auth)

35150 RADIATION CHEMICAL STUDIES OF PROTEIN REACTIONS: EFFECT OF IRRADIATION LIQUID CONTAINING AROMATIC HYDROCARBONS AND pH ON VISCOSITY. Nisizawa, Mizuho (Defense Academy, Yokosuka, Japan). J. Polym. Sci., Part A-1, 7: 1247-54(May 1969).

When protein is irradiated by γ rays from a ^{60}Co source in various liquids containing aromatic hydrocarbons, such as benzene, naphthalene, and phenanthrene, the effect of the radiation varies with the irradiation liquids containing aromatic hydrocarbons. Protein irradiated by γ rays from a ^{60}Co source in air showed the effect of pH on protein reactions. Empirical equations for the viscosity change were obtained. (auth)

35151 PULSE RADIOLYTIC INVESTIGATION OF THE DISSOCIATION EQUILIBRIUM OF THE MIXED RADICAL–ANION COMPLEXES $BrSCN^-$. Schoeneshoefer, M.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem., 73: 289-93(May 1969). (In German).

$BrSCN^-$ is produced besides the well known, short lived complexes Br_2^- and $(SCN)_2^-$ when Br^- is oxidized by OH in the presence of small amounts of SCN^- in aqueous solution. $BrSCN^-$ has maximum absorption at 4000 Å with $\epsilon = 7.3 \times 10^3\ M^{-1}\ cm^{-1}$. It is in equilibrium with $(SCN)_2^-$ and Br_2^-: $BrSCN^- + SCN^- \rightleftharpoons Br^- + (SCN)_2^-$, $BrSCN^- + Br^- \rightleftharpoons Br_2^- + SCN^-$. The equilibrium constants amount to $1.1 \cdot 10^2$ and 10^{-3}, respectively. Furthermore, the constants of the dissociation equilibria of $BrSCN^-$: $BrSCN^- \rightleftharpoons Br^- + SCN$, $BrSCN^- \rightleftharpoons Br + SCN^-$ were found to be equal to 6.0×10^{-4} M and 4.6×10^{-9}, respectively. (auth)

35152 CHROMATOPOLAROGRAPHIC INVESTIGATION OF RADIOLYTIC PRODUCTS IN THE AQUEOUS NITRATE–ETHYLENE SYSTEM. Broszkiewicz, R. K.; Przybylowicz, Z. (Inst. of Nuclear Research, Warsaw). Anal. Chem., 41: 1121-2(July 1969).

In a study of the radiolysis of aqueous solutions containing nitrates and organic compounds the technique of chromatopolarography was used to analyze the radiolytic products in the nitrate–ethylene system. Peaks from chromatopolarographic curves from irradiated solutions of the nitrate–ethylene system were identified by comparison with reference solutions. The data obtained indicated that NO_3^- ions are sorbed only after neutralization to undissociated HNO_2 molecules. The radiolytic products, H_2O_2, NO_2^- (in the form of HNO_2), and CH_3NO_2, are sorbed on strongly acid Dowex 50 W-X8, and their desorption proceeds in the order of increasing molecular weights as in the case of homologous series of nitroparaffins. (D.H.M.)

35153 PRIMARY RADICALS YIELDS IN THE RADIATION CHEMISTRY OF WATER AND AQUEOUS SOLUTIONS. Hayon, E. (Army Natick Labs., Natick, Mass.). pp 157-209 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

The primary yields of e_{aq}^-, OH radicals, and H atoms produced in the radiation chemistry of water and aqueous solutions was extensively reviewed. The dependence of these yields on hydrogen and hydroxyl ion concentration, and other solute concentrations in neutral solution, is shown to be proportional to the product $k \times C\ sec^{-1}$, where k is the rate constant of reaction of a solute with e_{aq}^- and/or OH radicals, and C is the concentration of the solute. Radical yields in the radiation chemistry of heavy water, as well as in the pulse radiolysis of H_2O and D_2O solutions, are reviewed. (auth)

35154 THE NATURE OF OXYGEN-CONTAINING INTERMEDIATES IN RADIATION CHEMISTRY AND PHOTOCHEMISTRY OF AQUEOUS SOLUTIONS. Czapski, G. (Hebrew Univ., Jerusalem). pp 211-27 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

The nature of HO_2, OH, O_3^-, and H_2O_3 is discussed. The spectra and pK of these species as well as their kinetic behavior are reviewed. (auth)

35155 THE HYDRATED ELECTRON, ITS DISCOVERY, ITS SPECTRUM, AND ITS USES: INTRODUCTORY REMARKS. Hart, E. J. (Argonne National Lab., Ill.). pp 73-82 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

The history of the discovery of the hydrated electron and its subsequent many uses in problems of reaction kinetics is briefly surveyed. The most recent data on the spectrum of the hydrated electron, from photo- and radiation-chemical experiments, are collated, and the results are used to derive G values and mechanisms in pulse radiolysis and flash photolysis studies of aqueous systems. (auth)

35156 PULSE RADIOLYSIS OF AQUEOUS ALKALINE SOLUTIONS. Rabani, J. (Hebrew Univ., Jerusalem). pp 229-39 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

Pulse radiolysis made it possible to measure several ionic dissociation constants of short-lived radical acids. A review on the ionic dissociation of OH radicals in aqueous solutions is included as well as some new data supporting the previously reported pK for OH. The reactivities of OH and O^- with a series of substrates were compared. OH seems to be more effective than O^- in electron transfer reactions. In H-abstraction reactions OH and O^- are equally reactive. (auth)

35157 PULSE RADIOLYSIS IN RADIOBIOLOGY: SOME RECENT STUDIES ON MODEL SYSTEMS. Adams, G. E. (Mount Vernon Hospital, Northwood, Eng.). pp 241-58 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

Pulse radiolysis studies on a number of model systems for radiobiology, including amino acids, enzymes, and compounds containing divalent sulfur are discussed. Reduction processes involving reduction-equivalent transfer between components are considered in detail. (auth)

35158 RADIOLYSIS OF NUCLEIC ACIDS AND THEIR COMPONENTS IN AQUEOUS SOLUTIONS. Scholes, G. (Univ. of Newcastle upon Tyne, Eng.). pp 259-85 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

The radiolysis of nucleic acids, purines, pyrimidines, nucleosides, and nucleotides in aqueous solution is critically surveyed. Rate constants with OH radicals, H atoms and hydrated electrons are given. (auth)

35159 APPLICATIONS OF RADIATION CHEMISTRY IN RADIOBIOLOGY AND RADIOTHERAPEUTICS. Mitchell, J. S. (Cambridge Univ., Eng.). pp 287-303 of Radiation Chemistry of Aqueous Systems. Stein, Gabriel (ed.). New York, John Wiley and Sons, Inc., 1968.

From 19th Farkas Memorial Symposium, Jerusalem, Israel. See CONF-671212.

This is a study of the molecular basis of the mechanisms of some important biological actions of ionizing radiations with the assistance of knowledge of fundamental processes in radiation chemistry. Detailed evidence is presented in support of the conclusion that a macromolecular lesion of DNA in the nucleoprotein system of the living cell is the cause of the delayed killing of mammalian cells by radiation, as observed, e.g., in the radiotherapy of human malignant tumors. The critical radiosensitive structure appears to be a macromolecule of DNA of molecular weight in the region of 10^{10}. Probably the basic lesion is a break of both strands of the essential DNA in vivo. A small number of the radiosensitive structures must be inactivated in a cell in order to produce a lethal effect. Contributory evidence from in vitro experiments is discussed. Natural and induced differences in the radiosensitivity of cells are considered in some detail. The general importance of repair and reconstructive processes after radiation damage is emphasized in relation to radioresistance. Some aspects of recent work on the role of sulphydryl groups and on the oxygen effect, with special reference to anoxia, are reviewed. Evidence provided by the study of certain chemical radiosensitizers, particularly under anoxic conditions, is presented and discussed. (auth)

35160 CONCERNING THE LOW-TEMPERATURE RADIOLYSIS OF SOLID BINARY MIXTURES OF CERTAIN DERIVATIVES OF BENZENE WITH TOLUENE. Trofimov, V. I. Kinet. Katal., 10: 52-6(Jan.-Feb. 1969). (In Russian).

Electron paramagnetic resonance was used to study the formation of radicals on low-temperature irradiation of binary mixtures of phenol, nitrobenzene, aniline, and halobenzenes with toluene. The relation of radiation yields of radicals to the concentration of components, the temperature of irradiation, and the radiation dose and the action of visible light on the irradiated samples were investigated. On the basis of experimental data, possible mechanisms of formation of radicals are discussed. (tr-auth)

35161 RADIOINDUCED AND THERMAL DECOMPOSITION OF SILVER SALTS, DETERMINED FROM THEIR DIELECTRIC CHARACTERISTICS. Zhuravlev, V. K.; Mikhailov, Yu. I. Kinet. Katal., 10: 89-95(Jan.-Feb. 1969). (In Russian).

Dielectric losses and porosities of silver oxalates and nitrates, with organic and inorganic additions, in the process of thermal decomposition and radiolysis were investigated. Effects related to the nonequilibrium state of partially decomposed crystallites are described. Comparison of the electric conductivity for variable and constant currents permits the contributions of the decomposition reaction and the defects in crystal structure to be determined. (tr-auth)

35162 RADIOLYSIS OF ALDEHYDES. Wheeler, O. H.; De Osborne, E. D. (Puerto Rico Nuclear Center, Mayaguez). Int. J. Appl. Radiat. Isotop., 20: 549-51(July 1969).

A study is described on the effect of ^{60}Co gamma radiation on the saturated aldehyde decanal, on the unsaturated aldehydes citral and citronellal, and on the aromatic aldehyde benzaldehyde. (auth)

35163 RADIATION-INDUCED DIMERIZATION OF 1,3-CYCLOHEXADIENE. SOLVENT EFFECTS AND THE FORMATION OF THE DIELS-ALDER DIMERS BY A CATIONIC CHAIN MECHANISM. Schutte, R.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Amer. Chem. Soc., 91: 3715-20(July 2, 1969).

The radioinduced dimerization of 1,3-cyclohexadiene (CHD) occurred by two simultaneous mechanisms: mechanism 1 produced mainly the endo and exo Diels–Alder products of 1, 4, 1', 2' addition; mechanism 2 produced mainly the cis–anti–cis and cis–syn–cis isomeric products of 1, 2, 1', 2' addition. Both mechanisms were sensitized by the aprotic solvents benzene, n-hexane, cyclohexane, and di-n-propyl ether, and were inhibited by the protic solvent ethanol. The relative efficiencies of the solvents for the sensitization of both mechanisms were: benzene > n-hexane ≈ cyclohexane > propyl ether. Mechanism 1 involved a cationic chain reaction in benzene, and probably also in the other aprotic solvents. In all the aprotic solvents the yield of the Diels–Alder products went through a maximum as the CHD concentration was increased. Thus mechanism 1 was inhibited by a large concentration of CHD. The maximum yield of the Diels–Alder dimer I was larger if the maximum occurred at a lower CHD concentration. The values of $G(D)_{max}$ and $[CHD]_{max}$ in each solvent were as follows: benzene, 11, 0.03 M; n-hexane, 6, 0.5 M; cyclohexane, 6, 0.7 M; di-n-propyl ether, 3, 4 M. There was no evidence of a chain in mechanism 2 and the yields of the corresponding dimers were relatively small. For example, in a 0.092 M solution of CHD in benzene, the G value of dimers from mechanism 1 was 16.3, while that from mechanism 2 was only 1.8. It appears that triplet-state CHD molecules were the immediate precursors of the dimers from mechanism 2, and that roughly half of the triplet CHD molecules resulted directly or indirectly from neutralization reactions. (auth)

35164 KINETICS OF IONIC PROCESSES IN THE RADIOLYSIS OF LIQUIDS. V. CATIONIC POLYMERIZATION OF ISOBUTYLENE UNDER ANHYDROUS CONDITIONS. Taylor, Robert B.; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Amer. Chem. Soc., 91: 3728-32(July 2, 1969). (ORO-2968-43).

By resorting to a rigorous experimental technique, it was shown that the rate of the radioinduced polymerization of isobutylene under anhydrous conditions is proportional to the 0.55 power of dose rate. In these circumstances, the kinetic chain lengths are extremely large with G(–m) values exceeding 10^8 molecules/100 eV at the lowest dose rate. These results are perfectly explicable on the basis of polymerization by free ions. The rate of polymerization is almost independent of temperature between 40 and –78°C, and the rate constant for propagation at 0°C is estimated to be 1.5×10^8 M^{-1} sec^{-1}. Chain transfer to monomer governs the molecular weight of the polymer which decreases as the polymerization temperature is raised. The results of this work cast considerable doubt on the interpretation of previous studies on the radioinduced polymerization in the presence of solid additives. (auth)

35165 UNSTABLE INTERMEDIATES. PART LXI. ELECTRON SPIN RESONANCE STUDY OF RADICALS AND RADICAL PAIRS IN IRRADIATED RESORCINOL AT 77°K. Campbell, D.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A., No. 10, 1494-8(1969).

The ESR spectra of powders and single crystals of resorcinol after exposure to γ rays at 77°K are interpreted in terms of the predominant formation of two types of radical pairs, both probably comprising m-hydroxyphenoxyradicals. The particular parent molecules involved are considered in the light of the known crystal structure, and a possible mechanism for the formation of these pairs is derived. The single-crystal spectra of the phenoxy-type radicals trapped singly are also reported and discussed. (auth) (UK)

35166 CHEMISTRY OF SOME SHORT-LIVED SPECIES IN SOLUTION. Kemp, T. J. (Univ. of Warwick, Coventry, Eng.). Chem. Brit., 5: 255-9(June 1969).

The use of flash photolysis, pulse radiolysis, and ESR to produce and characterize short-lived radical intermediates is described. Special attention is given to the contribution of pulse radiolysis. Developments in pulse radiolysis include characterization of excited states, hydroxyl radical, and the solvated electron. (51 references). (P.C.H.)

35167 RADIATION AND CHEMICAL STABILITY OF SPRAY ADDITIVES. Zittel, H. E.; Row, T. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 166-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35168 UTILIZATION OF POWER REACTOR AMERICIUM FOR ^{252}Cf PRODUCTION. Christman, R. P.; Cornman, W. R. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 54-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35169 RADIATION CHEMICAL PROCESSING WITH A FLUIDIZED RADIOISOTOPE REACTOR. Yang, John Y. (Western New York Nuclear Research Center, Inc., Buffalo); Thomas, Charles C. Jr.; Cullinan, Harry T. Jr. Trans. Amer. Nucl. Soc., 12: 57(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35170 STUDIES OF ENERGY TRANSFER BY PULSE RADIOLYSIS. Cundall, R. B. (Univ. of Nottingham, Eng.). pp 227-42 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Pulse radiolysis allows identification of transient species, such as free radicals, ions, and excited states, and the study of primary processes in which these participate, and has some advantages over flash photolysis in this connection. The type of energy transfer between molecules discussed is electronic excitation energy transfer, but reliable work has so far been carried out only with systems containing aromatic compounds; biological systems have not yet yielded quantitative information. Earlier work is first described, followed by discussion under the following headings: formation of triplet states in organic solvents; energy transfer and intersystem crossing in pulsed systems; nanosecond pulse radiolysis; and recent studies on biacetyl systems. Among conclusions reached are that electronic energy transfer processes, which have been clearly defined in radiolytic systems, follow the same principles as in photochemical systems, but the origin of the electronically excited states is somewhat uncertain. Sub-excitation electrons may play a more important role than expected. (UK)

35171 RADIOLYSIS OF FLUORESCEIN DYES. Grossweiner, L. I. (Illinois Inst. of Tech., Chicago. Michael Reese Hospital and Medical Center, Chicago). pp 277-301 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

The current status of fluorescein dye radiolysis is reviewed, with emphasis on fluorescein itself and the tetrabromo-derivative eosin. Earlier work is surveyed, together with that on methylene blue, and a summary is given of recent research using pulse radiolysis and ^{60}Co irradiations. It was found that the radiolysis of fluorescein and eosin in aqueous solution parallels their photochemistry in that semireduced and semioxidized radicals are significant initial products, leading to the colorless leuco base and colored oxidation products, respectively. It was also found that aerated solutions in the presence of an OH scavenger are quite resistant to ionizing radiation; a proposed explanation is that the scavenger suppresses oxidative attack on the dye, while oxygen oxidizes the initial reduction products, thereby restoring the dye. (UK)

35172 POSSIBLE SIGNIFICANCE OF DEFECT CENTRES IN THE RADIATION CHEMISTRY OF SOLIDS. Thomas, J. M.; Williams, J. O. (University Coll. of North Wales, Bangor). pp 485-92 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Information about primary processes in irradiated solids may sometimes be obtained by examining properties of unirradiated crystals into which lattice defects were introduced by thermal, mechanical, or other means. This is illustrated by results obtained on two solids of biological importance, namely sucrose and ice, and also on the model solid (with regard to theories of excitation transfer) anthracene. Types of lattice irregularities (point defects and dislocations) are first discussed, followed by results with the foregoing substances. (UK)

35173 THERMOLUMINESCENCE STUDIES OF IRRADIATION EFFECTS IN MOLECULAR SOLIDS. Thomas, B.; Houston, E.; Weeks, J. C. (Welsh Coll. of Advanced Tech., Cardiff, Wales). pp 493-501 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Thermoluminescence involves excitation, trapping and recombination processes, and provides an excellent technique for studying irradiation effects in solids, and the method is being applied to various materials of biological interest. Difficulties arise, however, in peak analysis and interpretation; for this reason thermoluminescence measurements are usually accompanied by measurements of fluorescence, optical absorption, ESR, or some other related property, in order to simplify interpretation. The theory and practice of thermoluminescence is first described, followed by a discussion on peak analysis, and some experimental results. Studies on polymeric materials (including polyethylene) showed that ionizing radiation, x rays, and uv light excite charge carriers into trapping states, and in some cases also produce new trapping states. The trapping states vary widely in characteristic activation energies, and in the escape frequencies required for the release of the trapped charge carriers. These carriers may be raised to excited bands optically or thermally, and hence reach the recombination centers located at impurities not generally linked to the main polymer chains. (UK)

35174 ASPECTS OF RADIATION REACTIONS IN POLYMERS. Charlesby, A. (Royal Military Coll. of Science, Shrivenham, Eng.). pp 323-31 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Aspects in which polymers are better models than low-molecular-weight organic materials for the complex macromolecules studied in radiobiology are discussed. The first of these depends on the high molecular weight of linear polymers, leading to information on the role of molecular mobility and molecular configuration in radiation reactions; with similar chemical structure greatly differing results may be obtained, depending on the degree of chain folding and crystallinity. The degree of regularity in geometrical arrangement of side groups about the main chain may also be highly relevant. By use of copolymers studies closely relevant to biological macromolecules may be carried out, and which would be difficult to parallel with low-molecular-weight compounds. Optical and ESR techniques can be readily applied. Changes are influenced by the presence of oxygen and other additives, as well as by temperature, often in a manner corresponding to that observed in biological systems. A valuable advantage is the relative ease of separation of purely physical and chemical changes common to all macromolecules from those of specific biological importance, enabling quantitative assessment of such effects under a much wider variety of conditions than can be followed in biological materials. Where partially crystalline or amorphous polymers do not constitute an adequate model, irradiation in the presence of solvents, and particularly water, may provide a closer analogy; this brings in both direct effects due to energy absorbed in the polymer, and indirect effects resulting from attack on the polymer by radiolysis products of the solvent. Irradiation protection may be offered by small amounts of additive, either reacting directly with radiolysis products, or with reactive groups formed in the polymer. An important fact is that polymer concentration can apparently reverse the nature of radioinduced reactions. The subject is discussed under the following headings: basic changes in irradiated polymers; intermediate reactions; polymers in solution. (UK)

35175 METHOD OF PREPARATION OF ^{137}Ba. (to Societe Saint-Gobain Nucleaire). French Patent 1,392,506. Filed Oct. 15, 1964.

Barium-137 was prepared by fixing ^{137}Cs on a solid ferrocyanide of a transition element which is fixed on an ion exchange resin, preferably of the Dowex or Amberlite type. Alternately the ^{137}Cs can be fixed on a ferrocyanide, which is incorporated in a collodion film prepared from a colloidal ferrocyanide obtained by mixing equal volumes of a solution of ferrocyanide of an alkali metal and a solution of a salt of a transition element by passing the colloidal ferrocyanide through an organic phase, by adding to the organic phase a solution of collodion, e.g., in ethyl acetate, and by spreading and drying the mixture so obtained. Two methods for elution of the ^{137}Ba are elution with an aqueous solution of a Na or Ba salt or of Ca gluconate or Ca levulinate and elution with a solution of a copper salt, preferably a saturated $CuCl_2$ solution containing 1 mole/l of KCl. Preferably the eluting agent is passed successively through a ferrocyanide that is fixed on the ion exchange resin and charged with ^{137}Cs and through an inactive ferrocyanide fixed on the resin. (NPO)

35176 PULSE RADIOLYSIS AND RADIOBIOLOGY. Adams, G. E.; Michael, B. D. (Mount Vernon Hospital, Northwood, Eng.). pp 333-52 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Although pulse radiolysis is a physical technique, it exploits the time of action of chemical change, and a promising approach in endeavoring to relate chemical and radiobiological processes is to attempt to establish broad correlative relationships between free radical lifetimes and reactivity, and also the dependence of biological endpoints on similar experimental parameters. Examples are given of some recent developments in this field, under the following headings; reducing effects of ionizing radiation (hydrated electrons, electron affinity, and electron transfer); radiosensitisation by electron-affinic compounds; pulse radiolysis of -SH compounds; and free radical repair by sulfhydryl compounds. (UK)

35177 PRINCIPLES, TECHNIQUES, AND THE DESIGN OF EXPERIMENT IN PULSE RADIOLYSIS. Adams, G. E.; Michael, B. D. (Mount Vernon Hospital, Northwood, Eng.). pp 77-102 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Pulse radiolysis is stated to be the radiation chemical analogue of flash photolysis, and is concerned with the various short-lived species (free radicals, radical-ions, excited species, etc.) that are produced in irradiated gaseous and condensed systems. These species are studied by spectrophotometric techniques, making use of their optical absorption properties in terms of wavelength, time, and other parameters. A review is given under the following headings: principles; equipment (pulsed radiation sources, light sources, irradiation cells, electron beam distribution and focusing, pulse monitoring, optical systems, photomultipliers and associated circuitry); experimental approach; radical-solute reactions (absorbing primary species, formation of transient absorbing products, formation of absorbing products in two or more time-resolved processes, transient nonabsorbing products, unimolecular decomposition reactions, determination of free radical equilibrium constants, effects of ionic strength). (UK)

35178 PROPERTIES OF SOLVATED ELECTRONS. Thomas, J. K. (Argonne National Lab., Ill.). pp 103-16 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

A review is given of recent data regarding solvated electrons that have emanated from γ radiolysis, flash photolysis, and pulse radiolysis. Studies on solvated electrons make use of the strong optical absorption spectrum of these species; data are now available for these species not only in water but also in alcohols, ethers, amines, hydrocarbons, etc. The review is made under the following headings: spectra of solvated electrons; and rate processes of solvated electrons (lifetimes, reactions with inorganic compounds, reactions with organic compounds, reactions of hydrated electrons with biological molecules in water, and reactions of solvated electrons in the "spur"). (UK)

35179 CHEMICAL TRANSFORMATION OF ORGANIC COMPOUNDS INDUCED BY γ IRRADIATION. Schulte-Frohlinde, D. (Kernforschungszentrum, Karlsruhe, Ger.). pp 117-29 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

A description is given of some of the methods commonly used to investigate the reactions of irradiation-produced OH radicals, solvated electrons, and H atoms with organic compounds in dilute liquid or frozen aqueous solutions. It is stated that the main difficulty in studying the radiation chemistry of solutions arises from the high number of reactive species formed during the primary processes; in water at least five reactive species are formed, and if all these react with the organic substance the reaction scheme is often too complex for analysis. In dilute solutions, however, only solvated electrons, H atoms and OH radicals can react with the solute. Experimental work is described in a study of the reactions of these species independently with the solute. Headings are as follows: Reactions of OH radicals (hydroxylation of aromatic compounds, reactions with 5-bromouracil in dilute aqueous solutions in the presence of oxygen); reactions of electrons; reactions of H atoms. (UK)

35180 RADIATION EFFECTS ON CARBOHYDRATES. Phillips, G. O. (Univ. of Salford, Eng.). pp 131-52 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

The most general effect of irradiation on carbohydrates is to cause oxidative degradation, and mechanisms of degradation of carbohydrate systems under γ-irradiation in aqueous solutions and in the solid state are discussed. Earlier work on carbohydrate systems is briefly reviewed, during which it was found that mechanisms involving radical and molecular products (H_2, H_2O_2, e^-_{aq}, H, and OH) from the radiolysis of water cannot satisfactorily account for the course of the carbohydrate radiolysis. The observed variation in product yields with solute concentration would not be anticipated if the chemical changes were due solely to the classical indirect action effects. It is possible that, in addition to ·OH radical abstration, other reactive species produced by water radiolysis initiate chemical reaction. In order to evaluate the contribution of the OH radical in relation to other processes leading to d-glucose decomposition the effect of concentration on low dose-rate ^{60}Co γ-irradiation was compared with pulse radiolysis studies with 4-MeV electrons. Studies on the γ-irradiation of carbohydrates in the solid state showed that these molecules can promote efficient energy transfer alone, and in association with other molecules. These observations have been utilized to protect carbohydrates from radiation damage and to study the nature of the excited states produced. The role of H-bonding in the solid systems and in aqueous solutions is considered. Headings are as follows: radiolysis of aqueous aldohexoses (chemical changes, pulse radiolysis); effects of radiation on the solid state (d-glucose crystals, cycloamylose complexes, amylose complexes). (UK)

35181 RADIATION EFFECTS ON CELLULOSE. Arthur, J. C. (Dept. of Agriculture, New Orleans). pp 153-81 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

The emphasis of the studies described is on the fibrous cotton cellulose normally used for textile purposes, but the conclusions apply to cellulose in general. Interests in the effect of high-energy radiation on cellulose include the radiosterilization of medical supplies and personal products; in this connection effects on the strength of the fibrous cellulose and on its absorption properties for liquids are important. A second interest is concerned with irradiation-initiated graft copolymerization reactions, for improvement of properties. Headings are as follows: fibrous cellulose (composition, morphology, chemical properties); energy transfer processes; primary effects (gas evolution, formation of free radicals, effect of lattice type, effect of oxygen, effect of water, trapped radicals); intramolecular energy transfer (energy localization, solid glucosides, fibrous cellulose); morphological properties; physical properties; chemical properties. It was found that the basic effect of radiation on cellulose is to initiate oxidative degradation. Processes occurring include dehydrogenation, destruction of anhydroglucose units to yield CO and CO_2, and cellulosic chain cleavage to yield a homologous series of products. (UK)

35182 WOOD–PLASTIC COMBINATION PRODUCED BY γ-IRRADIATION. Fukumoto, Tsugio; Akagi, Ryuichi; Tsurugi, Jitsuo. Annu. Rep. Radiat. Center Osaka Prefect., 9: 68-71 (1968).

Radioinduced polymerization of methyl methacrylate and styrene impregnated in persimmon and oak sapwoods under nitrogen pressure was investigated. The dose rates used were 1.5×10^5 R/hr and 3×10^5 R/hr. The relation between conversion (%) and total dose varied with dose rate. The conversion (%) increased with the increase of the total dose to a maximum and then decreased. Grafting (%) changed linearly with the concentration of the monomer and the maximum value, which is close to the theoretical amount, was obtained in the case of the monomer only. (auth)

35183 GAMMA-RAYS INDUCED CONDUCTIVITY IN INSULATING POLYMERS. IV. Okamoto, Shinichi; Furuta, Junichiro; Hiraoka, Eiichi. Annu. Rep. Radiat. Center Osaka Prefect., 9: 58-9(1968).

By heavy gamma-ray exposure of ^{60}Co the molecular structure of polyethylene (P.E.) can be changed drastically. Its γ-induced currents were measured at room temperature. The values of induced current decrease with preirradiation doses above 10^7 RAD. The value of induced current did not reach to the equilibrium value. The crystallinities of nonirradiated P.E. and of preirradiated at a dose of 10^8 RAD were measured using x-ray diffraction method. Differences in crystallinity were not found. (auth)

35184 ENERGETICS AND MECHANISMS IN RADIATION BIOLOGY. Proceedings of a NATO Advanced Study Institute held at Portmeirion, Wales, April 1967. Phillips, Glyn O. (ed.). London, Academic Press, 1968. 527p. 130s. (CONF-670422).

Thirty-two papers were presented, of which abstracts are given for twenty-five. Papers on photochemistry are not included among these abstracts. The review subjects range from primary radiation chemistry processes, energy transfer, chemical changes, etc., to the ultimate biological consequences of radiation action at the molecular level. New and refined techniques are also surveyed. (UK)

For abstracts of individual papers see: 35079, 35080, 35170–35174, 35176–35181, 35185–35187, 35648, 35649, 35651–35655, 35848, and 35956.

35185 PRIMARY PHYSICAL AND CHEMICAL PROCESSES. Weiss, J. J. (Univ. of Newcastle upon Tyne, Eng.). pp 1-9 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

The following topics in radiation chemistry are briefly discussed in relation to primary processes: water and aqueous systems; electron-hole pairs as primary active species; effect of scavengers; absorption spectra; electric conductivity; lifetime of active species; molecular yield mechanism; kinetic salt effect; and photochemistry. (UK)

35186 REACTIONS OF ELECTRON-HOLE PAIRS IN γ IRRADIATED ICE AND FROZEN AQUEOUS SOLUTIONS. Weiss, J. J. (Univ. of Newcastle upon Tyne, Eng.). pp 11-19 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

A study of the radiolysis of frozen aqueous solutions may serve to elucidate some aspects of the mechanism of the radiolysis of aqueous systems in general. A study of the transitory species trapped in an ice matrix also makes it possible to apply various spectroscopic methods for identification purposes. The subject is discussed under the following headings: acid frozen aqueous systems (reactions of electrons, formation and trapping of H atoms, formation of cationic radical ions; reactions of holes, formation of radical anions, trapping of radiation produced holes); alkaline frozen aqueous systems (reactions of electrons and holes; nature of color centers in irradiated alkaline ice). (UK)

35187 SOLVATED ELECTRON IN ICE. Kevan, L. (Univ. of Kansas, Lawrence). pp 21-33 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Among highly reactive chemical species produced in the radiolysis of water is that referred to as the "solvated electron"; it is the principal reducing species produced, and its reactions provide a key for understanding the effects of irradiation on water and aqueous biological systems. Frozen solutions offer the possibility of trapping reactive species such as electrons for study by optical and EPR techniques. A summary is given of the evidence for "solvated electrons" in ice and current studies in this field are surveyed, with particular reference to EPR methods. Headings are as follows: EPR of irradiated ice (neutral ice, alkaline ice); reactions of mobile electrons in ice (reactions with oxyanions, reactions with metal cations, competition kinetics); trapping site of e_t^- in ice (descriptive models, spatial distribution); and formation of trapped dielectrons in ice. (UK)

35188 SEVERAL PROPERTIES OF RADIATION-INDUCED GRAFT COPOLYMERS OF POLYETHYLENE WITH CONSIDERATION OF THE DISTRIBUTION OF ENERGY ABSORPTION. Pluemer, Friedrich (Karl-Marx-Univ., Leipzig). Kolloid-Z. Z. Polym., 229: 97-106(Feb. 1969). (In German).

The distribution of energy absorption of slow electrons influences certain properties of supplemental graft copolymerized samples; it was used to serve as a parameter for the study and preparation of graft copolymers. Specific effects of the distribution were obtained from colorability, mechanical properties, superficial electrical conductivity, and other properties. These properties were considered with respect to improvement and technical applications of polymer films. Energy absorption as a function of the range of the film thickness, and G as a function of dose, temperature, and time are graphed. A lower limit to the degree of grafting is defined as that which determines the beginning of change for a given property. The structure of resulting products is briefly discussed from the qualitative viewpoint. (BBB)

35189 FORMATION OF THE TRIPLET STATE OF NAPHTHALENE IN THE PULSE RADIOLYSIS OF GASEOUS MIXTURES OF BENZENE AND NAPHTHALENE. Nishikawa, Masaru; Sauer, Myran C. Jr. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 1-9(July 1, 1969).

A significant yield of the lowest triplet state of naphthalene was observed when 1.9 atm benzene containing small amounts of naphthalene was pulse irradiated in the gas phase at 120°C. The yield was independent of naphthalene concentration from −0.3 mole % to at least 3 mole %. Electron scavengers (SF_6 and CCl_4) decreased the yield by 70%, as did a positive-ion scavenger, triethylamine. This 70% is thought to originate by neutralization of $C_{10}H_8^+$ by $C_{10}H_8^-$. The other 30% of the triplet yield is thought to originate from benzene ($^3B_{1u}$) formed directly by the irradiation of the benzene vapor. Naphthalene was found to be 34 ± 4, 38 ± 4, and 18 ± 2 times more efficient in accepting energy from the benzene triplet than trans-butene-2, cyclohexene, and nitromethane, respectively. Similar results were obtained using 1.3 atm argon as the main gas, with about 3 mole % benzene and about 3×10^{-3} mole % naphthalene present at 25°C. In this case, the naphthalene triplet was formed after the pulse, and kinetic analyses of the curves as a function of naphthalene concentration allowed an evaluation of the benzene ($^3B_{1u}$) decay constant of 1.3×10^5 sec^{-1} at 18 torr benzene (which decreases with increasing benzene pressure) and of the rate constant for energy transfer from benzene ($^3B_{1u}$) to naphthalene of $(3.0 \pm 0.5) \times 10^{11}$ liter $mole^{-1} \cdot sec^{-1}$. Naphthalene was found to be 20 ± 3 times more efficient than trans-butene-2 in accepting energy from triplet benzene. (auth)

35190 THE USE OF NITROUS OXIDE IN ELUCIDATING MECHANISMS OF RADIOSENSITIZATION IN CHEMICAL AND BIOLOGICAL SYSTEMS. Nakken, K. F.; Brustad, T. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scand. J. Clin. Lab. Invest., 22: Suppl. 106, 41-52(1968).

Radiosensitizing effects of electron scavengers in aqueous solutions of aromatic compounds and of certain alkylating agents and organic nitroxide free radicals in suspensions of erythrocytes and bacteria are reviewed. Emphasis is put on the use of N_2O in elucidating mechanisms of radiosensitization in chemical and biological systems. Nitrous oxide can transform hydrated electrons into OH radicals, so it has been extensively used in pulse radiolysis experiments. The effects of N_2O were compared with that of various other electron scavengers upon the x-ray-induced degradation and hydroxylation of some pyridine and benzene derivatives. Results indicate that in neutral aqueous solutions of aromatic compounds the radiosensitizers exert their effect through: interference with back reactions involving e_{aq}^- and H; interaction with solute radicals; and conversion of e_{aq}^- and H into oxidizing radicals. For erythrocytes and bacteria, radiosensitizing mechanisms of some alkylating agents (iodoacetic acid and N-ethylmaleimide) and organic nitroxide free radicals were considered in view of their ability to interact with e_{aq}^-, OH, and vital biological targets. Experiments with the radiosensitizer triacetonamine-N-oxy in Escherichia coli are reported. (BBB)

35191 EFFECT OF RADIATION ON ELECTRICAL BEHAVIOR OF POLY-3-VINYL-9-ALKYLCARBAZOLES. Budnikova, E. S.; Sirotkina, E. E.; Lopatinskii, V. P.; Kessenikh, R. M. (Siberian Physical-Technical Inst., Tomsk, USSR). Vysokomol. Soedin., Ser. A, 11: 931-40(May 1969). (In Russian).

The electrical behavior of polymers based on carbazole was studied before and after irradiation with γ rays from ^{60}Co and with electrons at 4 MeV. The angle of dielectric losses and dielectric permeance were measured at temperatures from −150 to 250°C by means of a differential nonbalanced bridge. From variations in the electrical behavior of irradiated polymers, inferences about crosslinking on irradiation and about its mechanism were made. (auth)

35192 ANISOTROPY OF NITROGEN HYPERFINE COUPLING AND g FACTOR IN THE ESR SPECTRA OF TRAPPED ELECTRONS IN GAMMA-IRRADIATED CRYSTALLINE ORGANIC CYANIDES. Bonin, Michael A.; Takeda, Keiji; Williams, Ffrancon (Univ. of Tennessee, Knoxville). J. Chem. Phys., 50: 5423-4(June 15, 1969).

Observations on the orientation dependence of the ESR spectra of trapped electrons in gamma-irradiated acetonitrile-d_3 and succinonitrile-d_4 led to the conclusion that these electrons are trapped in the host crystal. (M.C.G.)

35193 HYDROXYL RADICALS IN X-IRRADIATED SINGLE CRYSTALS OF ICE. Box, Harold C.; Lilga, Kenneth T.; Budzinski, Edwin E.; Derr, Richard (Roswell Park Memorial Inst., Buffalo). J. Chem. Phys., 50: 5422-3(June 15, 1969).

Electron spin resonance spectroscopy was used to study the effect of x radiation on ice. Single crystals were irradiated at 77°K and subsequently measured at 4.2°K. The absorption contains three principal components, two of which are due to OH radicals in two different environments. The other one is thought to be due to an OH radical in yet another environment. (M.C.G.)

35194 THEORY OF THE TRAPPED DIELECTRON. Fueki, Kenji (Univ. of Notre Dame, Ind.). J. Chem. Phys., 50: 5381-5 (June 15, 1969).

The theory of the trapped dielectron in polar media was developed on the basis of the continuous dielectric model. The theory leads to a remarkably simple criterion for the energetic stability of the dielectron. Application was made to the calculation of the electronic properties of the trapped dielectron in aqueous systems. The transition energies calculated with low static dielectric constants are in the right energy region as compared to the absorption spectrum observed at low temperature. (auth)

35195 ON THE IRRADIATION OF POLY(VINYL CHLORIDE). Salovey, R.; Luongo, J. P.; Yager, W. A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Macromolecules, 2: 198-200(Mar.-Apr. 1969).

Electron spin resonance and visible absorption measurements were made following the irradiation and storage of poly(vinyl chloride) under vacuum and in the presence of a scavenger, to clarify the radiolytic mechanism. Molded and cast films of poly (vinyl chloride) were irradiated at 15°C in Pyrex tubes with 1-MeV electrons from a Van de Graaff generator at a dose rate of about 4 MRAD/min to a total dose of 8 MRAD. Absorption peaks between 300 and 700 mμ characterized the optical density of vacuum-molded films irradiated and measured under vacuum.

First-derivative ESR spectra of films molded, irradiated, and studied under vacuum revealed a symmetric singlet about 25 G wide. It was concluded that electron irradiation of poly(vinyl chloride) induces a radical chain dehydrochlorination reaction, which, under vacuum, yields stable polyenyl free radicals with sequences of conjugated double bonds. Delocalization of the electron in polyenyl free radicals produces a singlet in ESR. At high enough values of the sequence length, the optical absorption spectra may converge. The presence of reactive additives or chemical inhomogeneities in the polymer chain suppresses the formation of polyenyl radicals and optical absorption. (BBB)

35196 EFFECT OF (n,γ) RECOIL ON THE γ−γ ANGULAR CORRELATION IN POLYCRYSTALLINE Hf(IV) BENZOYLPHENYLHYDROXYLAMINE COMPLEX. Vargas, J. I.; Berthier, J.; Hocquenghem, J. C.; Ribot, J. J.; Boyer, P. (CEN, Grenoble, France). Proc. Roy. Soc. (London), Ser. A, 311: 191-5(June 24, 1969).

The time-dependent anisotropy of the differential 133−482 keV γ−γ angular correlation in synthetic, 3 and 24 h pile irradiated $(BPHA)_4$ Hf indicates the occurrence of considerable thermal neutron capture after-effects and suggest the formation of at least three chemical species in the irradiated complex. (auth) (UK)

35197 ON THE OXIDIZING RADICAL IN THE RADIOLYSIS OF AQUEOUS HYDROCHLORIC ACID. Hughes, G.; Makada, H. A. (Univ. of Liverpool). Int. J. Radiat. Phys. Chem., 1: 325-34(July 1969).

It was shown that the chlorine atom (or its counterpart Cl_2^-), produced in the radiolysis of aqueous hydrochloric acid, readily reacts with 2-propanol, much less readily with ethanol, and not at all with methanol. Scavenger studies clearly indicated that the chlorine atom is produced through two distinct precursors, one of which is the hydroxyl radical, which may also be scavenged by alcohols, and the other an unidentified precursor, possibly H_2O^+, which does not readily react with alcohols. (auth) (UK)

35198 RADIATION INDUCED OXIDATION OF SULFUR DIOXIDE IN THE PRESENCE OF WATER SATURATED VAPOUR. Sofronie, E.; Tarabasanu-Mihaila, E.; Ionescu, S. (Inst. of Atomic Physics, Bucharest). J. Inorg. Nucl. Chem., 31: 2095-2103(July 1969).

The γ-induced oxidation of sulfur dioxide in the presence of saturated water vapor was studied. The following parameters were varied: gas mixture composition, gas pressure, dose rate, and temperature. The formation of sulfuric acid obeys the parabolic law, $(\Delta m/q)^2 = kt$, both in the absence and in the presence of radiation. This law is characteristic for the processes taking place at the separation boundary of two phases. A linear dependence of the radiolytic yield on the reciprocal of the square root of the dose rate was found. The radiolytic oxidation is a radical chain reaction. (auth) (UK)

35199 COINCIDENCE OF TIMES FOR THERMAL DECAY OF TRAPPED ELECTRONS IN γ-IRRADIATED 3-METHYLPENTANE AT 77°K BY ELECTRON SPIN RESONANCE AND OPTICAL OBSERVATIONS. Tsuji, Kozo; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Int. J. Radiat. Phys. Chem., 1: 383-5(July 1969).

Agreement was obtained between ESR and optical measurements on the decay of trapped electrons in identical samples of γ-irradiated 3-methylpentane at 77°K. (auth) (UK)

35200 EXPERIMENTAL AND CALCULATED YIELDS IN THE RADIOLYSIS OF WATER AT VERY HIGH DOSE RATES. Willis, C.; Boyd, A. W.; Rothwell, A. E.; Miller, O. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Int. J. Radiat. Phys. Chem., 1: 373-81(July 1969).

Pure water, acidified water, and aqueous nitrous oxide solutions were irradiated with ≈100 ns pulses of electrons giving doses between 10^{19} and 10^{21} eV g^{-1}. For pure water $G(H_2)$ was found to be ≈1.0 at 10^{19} eV g^{-1} and decreased to ≈0.8 at 10^{21} eV g^{-1}. At the highest dose rate (10^{28} eV g^{-1} s^{-1}) $G(H_2)$ increased from 0.8 to 1.1 on decreasing the pH from 7 to 1. In nitrous oxide solutions the ratio $G(H_2)/G(N_2)$ changed from 0.19 at 10^{26} eV g^{-1} s^{-1} to > 1.0 at 10^{28} eV g^{-1} s^{-1}, reflecting a large decrease in $G(N_2)$ and a smaller increase in $G(H_2)$ over this range of dose rates. Generally good agreement was found between experimental results and those calculated using a computer. (auth) (UK)

35201 ELECTRICAL CONDUCTIVITY MEASUREMENTS FOR DETECTING CHARGED INTERMEDIATES FROM PULSE RADIOLYSIS. Beck, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Int. J. Radiat. Phys. Chem., 1: 361-71 (July 1969). (In German).

Charged intermediates from the radiolysis of aqueous solutions were detected by simultaneous optical absorption and electrical conductivity measurements. The construction of the conductivity cell, determination of the cell constant by means of benzyl chloride or tetranitromethane, the sensitivity of the conductivity measurements, and sources of error are discussed. The following examples are described: the determination of the mobilities of the hydrated electron and the O_2^- ion (190 ± 10 cm^2 Ω^{-1} at 22°C and 65 ± 8 cm^2 Ω^{-1} at 21°C, respectively) and of the rate constants of the reactions $O_2^- + OH$ ($8.0 \pm 1 \times 10^9$ l mol^{-1} s^{-1}) and $O_2^- + O_2^-$ (2k = 3.4×10^7 l mol^{-1} s^{-1}). (auth) (UK)

35202 SOME REACTIONS OF HYDRATED ELECTRON IN ACID MEDIUM (pH 0.6 TO 4.0). Micic, O.; Draganic, I. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Int. J. Radiat. Phys. Chem., 1: 287-95(July 1969).

It is shown that oxalic acid is a convenient scavenger for hydrated electrons in an acid medium. From competition experiments the following data were obtained, at $\mu = 0$ and for $k(e_{aq} + H_3O^+) = 2.36 \times 10^{10}$ l mol^{-1} s^{-1}: $k(e_{aq} + H_2C_2O_4) \approx (2.5 \pm 0.5) \times 10^{10}$ l mol^{-1} s^{-1}, $k(e_{aq} + HC_2O_4^-) = (3.4 \pm 0.4) \times 10^9$ l mol^{-1} s^{-1}, and $k(e_{aq} + C_2O_4^{2-}) = (4.8 \pm 0.3) \times 10^7$ l mol^{-1} s^{-1}. Also $k[H + H_2C_2O_4(HC_2O_4^-, C_2O_4^{2-})] \leq 10^6$ l mol^{-1} s^{-1}. The observed kinetic salt effects confirm that the fast reactions involve hydrated electrons. It can be concluded that at pH 1.3 to 4.0 $G(e_{aq})$ decreases from 3.3 ± 0.2 to 2.85 ± 0.15. It was also found that an increase in the oxalic acid concentration induces a decrease of $G(H_2)$. For the same reactivity $k(e_{aq} + S) \times [S]$ this decrease is smaller the higher the acidity. This points to the recombination of e_{aq} in the spur as the main source of $G(H_2)$, contrary to the recently presented arguments against the hydrated electron as the precursor of molecular hydrogen in the spur. (auth) (UK)

35203 CHERENKOV RADIATION FROM THE PULSE RADIOLYSIS OF WATER. Shaede, E. A.; Walker, D. C. (Univ. of British Columbia, Vancouver). Int. J. Radiat. Phys. Chem., 1: 307-24(July 1969).

Luminescence was observed from water irradiated with a very intense 20 ns pulse of 0.5 MeV electrons, and the angular distribution, visible spectrum, electron energy dependence, lifetime and photon yield of the light emission were determined. The influence of a few solutes on the luminescence was investigated. In addition, the emission was compared with that from methanol, benzene and cyclohexane. The data indicate that at least 90% of the luminescence in the visible spectrum was Čerenkov radiation and that the fluorescence or phosphorescence yields from water must have $G(h\nu) \ll 10^{-3}$. A combination of the Bethe stopping power relation with the Frank−Tamm theory of Čerenkov radiation is shown to account satisfactorily for the electron energy dependence of the emission. From the equation so derived the total number of photons between 4000 and 6000 Å per incident electron was estimated to be 3.8, in agreement with the experimental value. (auth) (UK)

35204 RADIATION INDUCED BONDING OF HEXAMETHYLDISILOXANE TO SILICA. Chahal, R. S.; St. Pierre, L. E. (McGill Univ., Montreal). Can. J. Chem., 47: 2311-14(June 15, 1969).

An infrared technique was used to study the interfacial interaction between silica and hexamethyldisiloxane systems in the absence and presence of a radiation field. In the absence of the radiation, physisorbed hexamethyldisiloxane and higher molecular weight silicone compounds could be completely removed from the silica surface. In the irradiated samples, however, relatively large amounts of hexamethyldisiloxane were found to be chemisorbed on the surface. The evidence presented supports a radiation-induced chemical bonding of the products of the radiolysis of hexamethyldisiloxane to a silica surface at coverages of less than a monolayer. (auth) (Canada)

35205 EVIDENCE OF AN AFTER-EFFECT IN THE (n,γ) REACTION ON POLYCRYSTALLINE HAFNIUM(IV) ACETYLACETONATE COMPLEX. Beraud, R. (Univ., Lyon); Berkes, I.; Daniere, J.; Levy, Michele; Marest, G.; Rougny, R.; Vargas, J. I. Proc. Roy. Soc. (London), Ser. A, 311: 185-90(June 24, 1969).

Perturbed differential angular correlation measurements were performed on the 133 to 482 keV γ-cascade of ^{181}Ta in synthetic and neutron-irradiated polycrystalline Hf $(AA)_4$ sources. Evidence is presented showing occurrence of different crystalline sites in the two cases. The experimental data were treated by means of a χ^2 test. Electric field gradients and asymmetry parameters are evaluated and discussed in terms of possible crystalline structures. (auth) (UK)

35206 RADIOLYSIS OF 1-OCTENE. Kourim, Pavel (Inst. of Nuclear Research, Rez, Czech.). Int. J. Radiat. Phys. Chem., 1: 345-59(July 1969).

1-Octene was γ-irradiated both pure and in the presence of scavengers, and the structure and origin of the individual dimers formed were studied. In pure octene the composition of the dimer mixture was found to be similar to analogous products in irradi-

ated 1-butene and 1-hexene. The main dimeric product, constituting more than one-third of the dimer fraction, was n-hexadecene (G = 0.55). Approximately one-half of the total dimer yield originated in radical reactions, as evidenced by the results with solutions containing oxygen or benzoquinone. The dienes, which were almost completely of radical origin, resulted from the combination of the allylic type octenyl radicals, while the saturated dimers were formed by the addition of the octyl radicals to octene. The yields of the isomeric 1- and 2-octyl radicals were in the ratio of approximately 1:3.5. The molecular ions $C_4H_{17}^+$ reacted with octene partly in a condensation reaction and partly in a proton transfer reaction. The former is about twice as probable as the latter. Both are inhibited by ammonia; the rate constant for the transfer of proton from $C_4H_{17}^+$ to ammonia is about thirty times higher than that for the ion-molecule condensation with octene. The $G(H_2)$ values, compiled from a number of published papers, when plotted as a function of the C-atom number (n) of straight-chain terminal olefins, give a straight line; this can be expressed as $G(H_2) = 0.46 + 0.06n$. Some further aspects of H_2 formation in the radiolysis of olefins are briefly discussed. (auth) (UK)

35207 SHORT-LIVED TRANSIENT SPECIES IN IRRADIATED n-HEXANE. Conrad, Edward E. (Harry Diamond Labs., Washington, D. C.); Silverman, Joseph. J. Chem. Phys., 51: 450-1(July 1, 1969).

Transient electrical conductance was observed in n-hexane at times ranging from 25 nsec to 2 msec after a 25-nsec pulse of bremsstrahlung. The early signal fell exponentially, indicating first-order decay with a lifetime that ranges from 30 to 50 nsec. This lifetime seemed to increase with decreasing oxygen content. (M.C.G.)

35208 ELECTRON SPIN RESONANCE STUDIES OF RADICALS CONDENSED FROM IRRADIATED WATER VAPOR: PARAMAGNETIC RELAXATION OF TRAPPED ELECTRONS IN ICE. Wardman, P.; Seddon, W. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 47: 2155-60(June 15, 1969). (AECL-3299).

The spin-lattice relaxation time T_1 of electrons (e_t^-) trapped in several ice matrices at 77°K was estimated to be of the order of 10^{-2} s by observation of the electron spin resonance (ESR) dispersion signal under fast passage conditions. These studies, together with measurements of the microwave power saturation of the ESR absorption signal indicate that there is little difference in T_1 at 77°K for e_t^- in solute-free polycrystalline H_2O or D_2O ice, γ-irradiated 8 M NaOH/H_2O or NaOD/D_2O glassy ices, and in 8 M NaOD/D_2O glasses in which the electrons were produced by photoionization of ferrocyanide ion. This indicates that the predominant spin-lattice relaxation mechanism is not cross relaxation, and that correlations between T_1 and line width or trap depth are inappropriate. (auth) (Canada)

35209 IONIC PROCESSES OF VINYL ETHERS IN IRRADIATED 3-METHYLPENTANE GLASS. Irie, Masahiro (Kyoto Univ.); Hayashi, Koichiro; Okamura, Seizo; Yoshida, Hiroshi. Int. J. Radiat. Phys. Chem., 1: 297-306(July 1969).

Electron spin resonance studies were carried out on 3-methylpentane glass containing n-butyl vinyl ether and methyl vinyl ether irradiated at 77°K by ^{60}Co γ-rays. In addition to 3-methylpentyl radicals, trapped electrons and cation radicals of vinyl ethers were observed. During the formation and the decay of the trapped electrons by thermal and photobleaching with infrared light, the charge balance of the ionic species was quantitatively followed. The electrons were liberated from 3-methylpentane molecules and trapped in the glass. The positive charges were transferred from the matrix to vinyl ethers to form the cation radicals, which recombined with the electrons. In the glass containing methyl vinyl ether dissociative electron capture of methyl vinyl ether occurred, giving methyl radicals. This electron capture process was very slow in comparison with that of alkyl halides. The yield of the trapped electrons increased remarkably with increasing concentration of added vinyl ethers. This is interpreted not only as stabilization of the electrons due to the added solute, but also as the possibility that vinyl ethers provide new sites for electron trapping. (auth) (UK)

35210 PULSE RADIOLYSIS OF HYDROGEN SELENIDE IN AQUEOUS SOLUTION. Schoeneshoefer, M.; Karmann, W.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Int. J. Radiat. Phys. Chem., 1: 407-23(July 1969). (In German).

The rate constants of the reactions of free radicals resulting from the radiolysis of water containing H_2Se and HSe^- were determined. H_2Se is also oxidized by organic radicals. An intermediate complex is formed in these reactions: $R + H_2Se \underset{k}{\overset{K}{\rightleftharpoons}} H_2SeR \rightarrow HSe + RH$. The equilibrium constant K and decay constant k were measured for various complexes (H_2SeR). Hydrogen diselenide, H_2Se_2, was the final product of the pulse radiolysis. The spectrum of this was identical with the spectrum of the product which is obtained in the autoxidation of H_2Se in aqueous solution at low conversions. The pK-values of the equilibria $H_2Se_2 \rightleftharpoons H^+ + HSe_2^-$, and $HSe_2^- \rightleftharpoons H^+ + Se_2^{2-}$ were found to be 1.7 and 9.3, respectively. The HSe radical is formed as an intermediate of the radiolysis. HSe has an absorption maximum at 3500 Å ($\epsilon = 3.0 \times 10^2$ l mol^{-1} cm^{-1} = 30 m^2 mol^{-1}), and Se^- at 4500 Å ($\epsilon = 3.8 \times 10^2$ l mol^{-1} cm^{-1} = 38 m^2 mol^{-1}). The rate constants 2k of the reactions $2HSe \rightarrow H_2Se_2$ and $2Se^- \rightarrow Se_2^{2-}$ were found to be 8.1×10^9 and 4.6×10^9 l mol^{-1} s^{-1}, respectively. HSe can form a complex with HSe^- (k about 5×10^9 l mol^{-1} s^{-1}). $H_2Se_2^-$ absorbs at 4100 Å with $\epsilon = 8.6 \times 10^3$ l mol^{-1} cm^{-1} = 860 m^2 mol^{-1}. The constant of the equilibrium $H_2Se_2 \rightleftharpoons HSe + HSe^-$ was found to be 6×10^{-5} mol l^{-1}. $H_2Se_2^-$ disappears by second order at pH values below about 3.8 (pK of H_2Se), which is explained by the combination of HSe radicals present in the equilibrium. At high pH values, $H_2Se_2^-$ decays by first order with a half-life of 5 μs (pH = 8 to 12) which is independent of the HSe^- concentration. The equilibrium $H_2Se_2^- \rightleftharpoons H_2Se + Se^-$ is discussed in order to explain the effects. (auth) (UK)

35211 PULSE RADIOLYSIS OF SIMPLE MERCAPTANS IN AIR-FREE AQUEOUS SOLUTION. Karmann, W.; Granzow, A.; Meissner, G.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Int. J. Radiat. Phys. Chem., 1: 395-405 (July 1969). (In German).

The rate constants of the reactions of OH radicals, hydrated electrons, and free organic radicals with some mercaptans (RSH) were determined. The radical anion $RSSR^-$ is an intermediate product of the oxidation of the mercaptans. It strongly absorbs at 4200 Å (2-mercaptoethanol) and 4100 Å (methylmercaptan) and is in equilibrium with the RS radical ($RSSR^- \rightleftharpoons RS^- + RS$). The equilibrium constant amounts to 5.5×10^{-4} mol/l for 2-mercaptoethanol. The RS radicals combine with $2k = 5.2 \times 10^9$ l mol^{-1} s^{-1}. In strongly alkaline solutions a particle absorbing at 3000 Å appears instead of $RSSR^-$, to which the structure of a carbon radical anion ($\cdot CH_2-S^-$ in methylmercaptan) is tentatively attributed. (auth) (UK)

35212 USE OF A Pt MICROELECTRODE FOR THE STUDY OF THE GAMMA-RADIOLYSIS OF AERATED AQUEOUS SOLUTIONS OF FERRO- AND FERRICYANIDES. Busulini, Loris (Univ., Padua); Cescon, Paolo. Int. J. Radiat. Phys. Chem., 1: 387-93(July 1969).

The radiolytic behavior of ferro- and ferricyanide in acid and alkaline solutions was studied using a polarized platinum microelectrode. Use of the current/voltage curves permits the direct determination of the decrease of ferricyanide and the increase of ferrocyanide in aerated alkaline solutions under gamma irradiation. In aerated 0.4 mol/l H_2SO_4 solutions it was possible to measure the radiolytic oxidation of ferrocyanide and the formation of H_2O_2. The G values of the various radiolytic reactions were obtained independently. The experimental results agree very well with those of Haissinsky et al. on the basis of the formation of ferro-pentacyanide. (auth) (UK)

35213 ELECTRON SPIN RESONANCE STUDIES OF RADICALS CONDENSED FROM IRRADIATED WATER VAPOR: REACTIONS OF THE RADICALS. Wardman, P.; Seddon, W. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 47: 2149-54(June 15, 1969). (AECL-3298).

Electrons and hydroperoxyl radicals are trapped in polycrystalline ice after irradiation of water vapor and rapid condensation to 77°K. Using higher sample flow rates than in the earlier work of Seddon, Smith, and Bindner, the electron spin resonance spectra of the trapped electrons (e_t^-) were obtained in both H_2O and D_2O ice with negligible interference from the underlying $HO_2\cdot(DO_2\cdot)$ radicals. Addition of $C(NO_2)_4$, H_2O_2, $(CH_3)_2SO$, and O_2 as radical scavengers confirmed the earlier prediction that reactions with the radicals do not occur in the vapor phase in this system. The results with $C(NO_2)_4$ and H_2O_2 also provided chemical evidence consistent with the spectroscopic assignment for $HO_2\cdot(DO_2\cdot)$ radicals. Experiments with added isobutylene suggested that hydrogen atoms are formed (possibly in a post-irradiation reaction during condensation) and are also produced on photobleaching e_t^- at 77°K. (auth) (Canada)

35214 EFFECT OF OXYGEN ON THE DETERMINATION OF HYDROGEN ATOM YIELDS IN IRRADIATED ICE MATRICES. Holmes, D. E.; Nazhat, N. B.; Weiss, J. J. (Univ. of Newcastle-upon-Tyne, Eng.). Z. Naturforsch., 24a: 481(Mar. 1969).

ESR studies were carried out on the power saturation of hydrogen atoms in acid ices and it was found that under comparable conditions there is a very marked affect of oxygen on the magnitude of the ESR signals of the hydrogen atoms. Experiments were carried out with 1M H_2SO_4. It was concluded that the hydrogen atom intensities from irradiated acidic ices cannot be compared

unless the microwave power is below the power-saturation value. Results were negative in investigations of the effect of oxygen on the relaxation time of electrons in alkaline ice. (M.C.G.)

35215 EFFECTS OF LUMINESCENT SUBSTANCES ON HYDROGEN YIELDS FROM RADIOLYSIS OF AROMATIC SOLVENTS. Gurskii, M. N.; Tsoi, A. N. (Inst. of Nuclear Physics, Tashkent). Khim. Vys. Energ., 3: 187-8(Mar.-Apr. 1969). (In Russian).

Measurements were made on the hydrogen yields from the radiolysis of benzene and toluene in the presence of p-terphenyl by ^{60}Co γ rays in the range of 6×10^{17} to 10^{20} eV/cm^3. The hydrogen yields were measured by the manometric method of thoroughly cooling the irradiated solution to the temperature of liquid nitrogen. From the results, it was found that the mechanism of formation of hydrogen by monomolecular decomposition of aromatic liquids is not a unique situation. The participation of excited molecules in the reactions of the formation of hydrogen is also possible. A considerable contribution can be obtained in the reaction $C_6H_6 + C_6H_6 \rightarrow H_2 + C_6H_5C_6H_5$. The results confirm the existence of a protective effect of solvents by luminescent substances against small radiation doses. (P.C.H.)

35216 RADIATION INDUCED DIMERIZATION OF 2- AND 3-METHYL-2-PENTENES. Brash, J. L.; Golub, M. A. (Stanford Research Inst., Menlo Park, Calif.). Can. J. Chem., 47: 3077-9(Aug. 15, 1969).

The dimers formed in the electron irradiation of 2- and 3-methyl-2-pentenes were found to have average unsaturations of 1.53 and 1.35 double bonds per dimer molecule, respectively, and were formed with G values of 2.6 and 1.8, respectively. The dimers were considered to form by both ion-molecule and radical mechanisms. (auth) (Canada)

35217 KINETICS OF RADICAL PRODUCTION IN THE LOW-TEMPERATURE RADIOLYSIS OF ORGANIC COMPOUNDS. Trofimov, V. I.; Buben, N. Ya. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 3: 116-20(Mar.-Apr. 1969). (In Russian).

Electron paramagnetic resonance was used to study the kinetics of the production of radicals in the low-temperature radiolysis of aromatic and saturated hydrocarbons and their derivatives. In the compounds studied, the production of radicals is described by the equation $d[R]/dt = Gj - kj[R]$. The difference in quantities, k, for aromatic and aliphatic hydrocarbons is discussed. The mechanism for radical extinction by radiation in the compounds is also discussed. The results showed that the mechanism of extinction depends on the distribution and form of the radicals. (tr-auth)

35218 THE RADIOLYSIS OF ACETONE. IV. THE REACTIONS OF Cu^{2+} AS ACCEPTOR IN LIQUID PHASE RADIOLYSIS. Larin, V. A.; Ermakova, G. L.; Bakh, N. A. (Inst. of Electronics, Moscow). Khim. Vys. Energ., 3: 121-5(Mar.-Apr. 1969). (In Russian).

Spectrophotometric studies were made on the reduction of Cu^{2+} to Cu^+ in the radiolysis of acetone solutions in relation to temperature and dose. The results showed that from –80 to 0°C, the yields $G(-Cu^{2+}) = 7.5 \pm 0.5$ remained constant and did not depend on the dose. Above approximately 10°C the chain process of reduction, which was characterized by an activation energy of ~18 kcal/mole and by the quadratic breaking away of chain, was developed. It was established that this process is stipulated by participation in the reactions of chlorine ions. A mechanism based on the interaction of initial radical products of the radiolysis of acetone with the Cu^{2+} ion is proposed. (tr-auth)

35219 EFFECTS OF DOSE RATE ON THE FORMATION OF UNSATURATED HYDROCARBONS IN THE GAMMA-RADIOINDUCED THERMAL CRACKING OF n-HEPTANE. Gabsatarova, S. A.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). Khim. Vys. Energ., 3: 126-9(Mar.-Apr. 1969). (In Russian).

Studies were made on the relation of the radiation yield of the unsaturated compounds to the radiation-thermal cracking of n-heptane as a function of dose and temperature. It was found that with an increase in temperature and a decrease in dose, the yield of the unsaturated compounds increased. With low doses the yield was constant and with increased doses the yield decreased. The mechanism of formation of the unsaturated compounds is discussed. (tr-auth)

35220 PRODUCTION OF FLUORINATED POLYMERS BY RADIOINDUCED REACTION OF UNSATURATED HYDROCARBONS WITH FLUOROCARBONS. Matveeva, L. P.; Timofeev, V. D.; Borisov, E. A. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 130-2(Mar.-Apr. 1969). (In Russian).

Studies were made on the physicochemical properties of fluorinated polymers obtained by the radioinduced reaction of unsaturated hydrocarbons with fluorocarbons. Infrared and mass spectrometry were used to study the structure of the polymer. The system $C_2H_2-CF_4$ was irradiated at room temperature by fast electrons at a dose of 2.3×10^{18} to 4.7×10^{18} eV/cm^3. In all mixtures studied, the amount of fluoride in the polymer corresponded to a radiative yield of bound fluoride of ~4.2 atoms per 100 eV and the radiative yield of consumed acetylene dropped with the increase in content of CF_4 from 15.5 moles/100 eV for 50% up to 5 mole/100 eV for 90.9%. (tr-auth)

35221 RADIATION CHEMISTRY OF POLYACRYLAMIDE. I. ESR STUDY OF PARAMAGNETIC CENTERS IN IRRADIATED POLYACRYLAMIDE. Milinchuk, V. K.; Dudarev, V. Ya. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 133-9 (Mar.-Apr. 1969). (In Russian).

EPR spectral studies were made on the γ radiation yield (G) of paramagnetic centers (PC) in polyacrylamide, which was polymerized in the solid phase (PAA-1) and in dilute aqueous solution (PAA-2). In PAA-1 and PAA-2, ion-radicals disappeared upon irradiation by visible light. Photoannealing caused ion-radicals in PAA-1 to completely transform and those in PAA-2 to partially transform into radicals with the structure $-CH_2-C(CONH_2)-CH_2-$, which gave an EPR spectrum of five lines with hyperfine structure splitting of 22 Oe. Possible reasons for these effects on the formation and nature of pc in the polymer are discussed. (tr-auth)

35222 PHOTOCHEMISTRY OF FREE RADICALS. PHOTOTRANSFORMATION OF STABILIZED ALLYL RADICALS. Roginskii, V. A.; Pshezhetskii, S. Ya. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 140-6(Mar.-Apr. 1969). (In Russian).

The methods ESR and low-temperature spectroscopy were used to study the phototransformation of stabilized allyl radicals $CH_2-(CH)_n-CH_2$, which are formed by γ irradiation of dilute allyl chloride and allyl bromide solutions in 3-methylpentane. Under light at $\lambda \leq 410$ nm, allyl radicals are transformed to alkyl radicals in 3-methylpentane. It is assumed that the transformation is the result of the interaction of radicals $CH_2-(CH)_n-CH_2$ with the nearby molecules of 3-methylpentane. More obscure processes of the alkyl radical transformation into allyl radicals were also studied and their mechanisms are proposed. (tr-auth)

35223 MEASUREMENT OF ABSORBED DOSES OF HEAVY CHARGED PARTICLES AND GAMMA-NEUTRON RADIATION WITH CELLULOSE DIACETATE FILMS. Lavrentovich, Ya. I.; Zverev, A. B.; Velikovskii, A. A.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). Khim. Vys. Energ., 3: 147-51(Mar.-Apr. 1969). (In Russian).

The results of studies on the possibility of using cellulose diacetate films for measuring absorbed doses of heavy charged particles and γ–neutron radiation from nuclear reactors showed that they can be used successfully in the range from 2 to 70 Mrad with an accuracy of ±5%. Changes in the low proton energy (LPE) from 0.2 to 56 keV/μ, temperatures from –196 to 120°C, and dose in wide limits did not affect the optical density of films of 320 mμ. (tr-auth)

35224 RADICALS IN THE RADIOLYSIS OF WATER ABSORBED ON SILICA GEL. Krylova, Z. L.; Dolin, P. I. (Inst. of Electronics, Moscow). Khim. Vys. Energ., 3: 152-6(Mar.-Apr. 1969). (In Russian).

ESR spectral studies showed that in the γ irradiation of the silica gel–adsorbed water system at 77°K the main signal for silica gel decreased with increase in amount of water. The yield of atomic hydrogen also decreased sharply in the presence of water depending on the amount of water adsorbed. The mechanism for the formation of hydrogen atoms during the irradiation of silica gel is discussed. (tr-auth)

35225 CERTAIN REGULARITIES AND REACTIONS OBSERVED DURING THE IRRADIATION OF SULFUR-CONTAINING RESINS IN WATER. Tulupov, P. E.; Kasperovich, A. I. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 157-61(Mar.-Apr. 1969). (In Russian).

It is proposed that the decrease in exchange capacity of sulfur-containing resins by irradiation in water is described by a bimolecular reaction in which sulfone and sulfuric acid products are formed. It is suggested that upon irradiation the sulfones are transformed mainly in sulfuric acid and partially in sulfoxides. A system of differential equations is proposed to describe the kinetics of decrease of the amount of sulfo groups in tar and the breakdown of sulfones upon irradiation. Rate constants for the reactions were determined. (tr-auth)

35226 KINETICS OF ACCUMULATION OF HYDROCYANIC ACID DURING RADIATION-CHEMICAL FIXATION OF NITROGEN IN MIXTURES WITH METHANE OR ETHYLENE. Podkhalyuzin, A. T.; Trishkin, A. E.; Vereshchinskii, I. V. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 178-9(Mar.-Apr. 1969). (In Russian).

Data are given on the preparation of HCN by the action of accelerated electrons on mixtures of nitrogen with methane or ethylene. The energy of activation of the formation of HCN in the mixture $N_2-C_2H_4$ was close to 0. In the case of methane, G-(HCN) increased with increase in temperature from 28 to 400°C. Reasons for the low value of E_{act} (energy of activation) are discussed. (tr-auth)

35227 THE RADIOCHEMICAL DETERMINATION OF PRODUCTS OF THE RADIOLYSIS OF RADIOACTIVE Ba, Sr, AND Ca SULFATES. Gromov, V. V.; Spitsyn, V. I. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 181-2(Mar.-Apr. 1969). (In Russian).

Electron paramagnetic resonance X (EPR) was used to establish the formation of ion-radicals SO_4^-, SO_3^-, and SO_2^- in the radiolysis of sulfates. Pure β-emitters with maximum energies of 167 and 254 keV were used. If crystals of sulfates contain the groups SO_3^- and SO_2^-, which are formed as a result of self-radiolysis, then the liquid phase from the dissolution of the salts in an acid environment without oxidizers contains SO_2. In the case of SO_3^-, SO_2 is formed according to the reaction: $SO_3^- + 2HCl \rightarrow SO_2 + 2Cl^- + H_2O$. These results indicate the absence of salt transmission from traps during degasification. (tr-auth)

35228 RADICAL YIELDS IN THE RADIOLYSIS OF ALIPHATIC THIOLS AS A FUNCTION OF THE HYDROCARBON CHAIN. Bichiashvili, A. D.; Barsegov, R. G.; Nanobashvili, E. M. (Inst. of Inorganic Chemistry and Electronics, Tbilisi, USSR). Khim. Vys. Energ., 3: 182-3(Mar.-Apr. 1969). (In Russian).

Electron Paramagnetic Resonance (EPR) was used to study fast-frozen specimens of alkanethiols with the formula $C_nH_{2n+1}SH$ where n = 2,3,4,5,6, or 16. Results are given for the accumulation of radicals in butanethiol and hexanethiol at 77°C and for the relation of the radiation yield with radical formation in γ-irradiated n-alkanethiols as a function of the energy fraction absorbed by the alkyl part of the molecule. (tr-auth)

35229 ESR STUDY OF RADICALS FORMED ON GAMMA IRRADIATION IN CS_2-3-MP GLASSES. Zador, Erika. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 17: 135-41(1969). (In Hungarian).

The behavior of some transient species produced by gamma irradiation at 77°K in CS_2-3-methylpentane glass was studied. Among other entities the formation of the radical ion CS_2^- was observed. The ESR spectrum of CS_2^- can be reversibly photobleached, i.e., it appears on moderate heating. The phenomenon is interpreted as resulting from the associative character of the CS_2 molecules, that is the unpaired spins of the CS_2^- ions formed close to one another are supposed to compensate one another in a reversible manner. (auth)

35230 THE BEHAVIOUR OF RADIO-IODINE RECOILS FORMED BY NEUTRON AND PROTON IRRADIATION OF SOME SOLID CESIUM COMPOUNDS. Dema, I. (Inst. of Atomic Physics, Bucharest); Zaitseva, Natalia G. J. Inorg. Nucl. Chem., 31: 2311-18(Aug. 1969).

The chemical states of radioiodine formed by 14.6-MeV neutron and 660-MeV proton irradiation of different crystalline cesium compounds were determined. The radioiodine distribution in oxidized and reduced forms depends both on the radioiodine defect concentration and lattice composition. By thermal annealing large changes in the yield of oxy-forms were noticed. (auth) (UK)

35231 BETTER ADHESIVES, FIBERS VIA RADIATION? Can. Chem. Process., 53: 71-4(May 1969).

Industrial applications of radiation processes using sources such as ^{60}Co are surveyed. Possible new improved products including paints and organometallics to become available by in-situ polymerization are considered. Economics of the new processes are compared with conventional manufacturing methods now in use. (F.S.A.)

35232 ELECTRON SPIN RESONANCE STUDY OF γ-IRRADIATED ETHYLENIMINE IN THE SOLID STATE. Cordischi, D.; Di Blasi, R. (CNEN, Rome. Univ., Rome). Can. J. Chem., 47: 2601-3(July 15, 1969).

The electron spin resonance (ESR) study of the ethylenimine in polycrystalline and glassy state shows that the radical $\overset{CH_2-CH_2}{\diagdown N \diagup}$ is formed by γ-irradiation at 77°K. The features of the ESR spectrum of this radical are discussed in terms of the isotropic and anisotropic hyperfine coupling constants of the hydrogen and nitrogen nuclei. The effects of bleaching the γ-irradiated sample with visible and ultraviolet light are also reported. (auth) (Canada)

35233 γ-RADIOLYSIS OF CYCLOHEXANE WITH ELECTRON SCAVENGERS. VII. PERFLUOROCYCLOHEXANE AND PERFLUOROBENZENE AS ELECTRON SCAVENGERS. Sagert, N. H.; Reid, J. A.; Robinson, R. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 47: 2655-60(July 15, 1969). (AECL-3317).

The room temperature, liquid phase radiolysis of cyclohexane was investigated using perfluorocyclohexane (C_6F_{12}) and perfluorobenzene (C_6F_6) as electron scavengers. Yields of the respective monohydrofluorocarbons were investigated over several orders of magnitude scavenger concentration. The $C_6F_{11}H$ yield from the C_6F_{12}-cyclohexane system was previously shown to result from electron capture by C_6F_{12}. The data over the extended concentration range were used to calculate a total ion yield of 4.3 ± 0.2 G units and a free ion yield of 0.14 ± 0.02 G units. With C_6F_6 as an electron scavenger, hydrogen, cyclohexene, and dicyclohexyl yields were all reduced. However, C_6F_5H yields were much lower than the $C_6F_{11}H$ yields from C_6F_{12}. On changing the neutralization step by adding the proton scavenger ethanol, C_6F_5H yields were obtained equal to the $C_6F_{11}H$ yields from C_6F_{12}. Thus C_6F_6 is as efficient an electron scavenger as C_6F_{12}. Since a change in the neutralization process produces a large change in yield, it is likely that C_6F_5H (or $C_6F_5^-$) is produced in the neutralization process. (auth) (Canada)

35234 PRIMARY YIELDS AND MECHANISM IN THE RADIOLYSIS OF GASEOUS AMMONIA. Willis, C.; Boyd, A. W.; Miller, O. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 47: 3007-16(Aug. 15, 1969). (AECL-3325).

Ammonia vapor was irradiated with single pulses of electrons at a very high dose rate (10^{27} eV g^{-1} s^{-1}) with a Febetron 705. At this dose rate radical-product reactions are not significant. In pure ammonia, hydrogen, nitrogen, and hydrazine are produced and the yields found at 10^{27} eV g^{-1} s^{-1} are: $G(H_2) = 3.58 \pm 0.08$; $G(N_2) = 1.00 \pm 0.05$; $G(N_2H_4) = 0.58 \pm 0.05$. The yields are independent of pressure from 1 to 5 atm and of temperature between 20 and 200°C. Above 250°C the yields of all three products increase significantly and this is due to reaction $H + NH_3 \rightarrow H_2 + NH_2$ competing with radical-radical reactions. A rate constant for this reaction was determined, $k_1 = 4 \pm 2 \times 10^9 \exp(-10{,}000 \pm 1{,}500/RT)$ 1 $mole^{-1}$ s^{-1}. Product yields were measured for ammonia-propene mixtures. These yields allowed the determination of the primary radiation yields $G_{NH} = 0.74$; $G_{H_2} = 0.74$; $G_{NH_2} = 4.8$; $G_H = 4.8$; and $G(-NH_3) = 5.4$. (auth) (Canada)

35235 NEUTRON INDUCED ACTIVITIES IN ALUMINIUM CONTAINERS. Sutherland, A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Int. J. Appl. Radiat. Isotop., 20: 604-5(Aug. 1969).

Gamma spectrography was used to determine the activities produced in aluminum cans after exposure in a nuclear reactor. The results showed that ^{56}Mn, ^{64}Cu, ^{72}Ga, and ^{24}Na were present (in addition to 2.3-min ^{28}Al, which is initially by far the most important activity). ^{24}Na was produced from the fast neutron reaction. Thermal neutron reactions acting on impurity Mn and Ga produce ^{56}Mn (2.58-hr) and ^{72}Ga (14.1-hr). Depending on the position in the reactor, each of these may be expected to make an initial contribution to the unshielded exposure rate of the same order as that due to fast-neutron ^{24}Na. (P.C.H.)

35236 DEGRADATION AND ANTICARBOXYLESTERASE ACTIVITY OF DISULFOTON AND PHORATE AFTER ^{60}Co GAMMA IRRADIATION. Grant, D. L.; Sherwood, C. R.; McCully, K. A. (Dept. of National Health and Welfare, Ottawa). J. Ass. Offic. Anal. Chem., 52: 805-11(July 1969).

Disulfoton and phorate were subjected to gamma radiation from ^{60}Co at dose levels of 0, 0.1, 0.5, 1, 2, and 4 MRad. The inhibition of beef liver carboxylesterases by disulfoton and phorate in vitro was greater with increasing doses of radiation. The degradation of these organophosphorus pesticides was monitored by GLC with electron capture and phosphorus detectors, by TLC with detection by Brilliant green, and by enzyme inhibition with 5-bromoindoxyl acetate as substrate. The pesticides were degraded to the greatest extent in hexane or acetone solution. Less decomposition occurred at low temperatures. The sulfoxide and oxygen analog were present in most irradiated samples. The sulfone, oxygen analog sulfone, and oxygen analog sulfoxide were present in some of the disulfoton and phorate samples which were irradiated with 4 MRad. (auth)

35237 RADIATION DAMAGE IN SINGLE CRYSTALS OF CYSTEINE. Wheaton, R. F.; Ormerod, M. G. (Royal Military Coll. of Science, Shrivenham, Eng.). Trans. Faraday Soc., 65: 1638-48(June 1969).

The technique of electron spin resonance (ESR) was used to study the free radicals produced by γ radiolysis of cysteine single crystals at 77°K. By controlled warming, or further irradiation with ultra-violet light, six different spectra were obtained, four

of which were shown to arise from one radical, $RCH_2S\cdot$. The differences in the spectra are explained by conformational and environmental differences in the free radical. The conformational changes lead to an interaction of the unpaired electron with a neighboring sulphydryl group, giving rise to uniquely large anisotropies in the spectroscopic splitting factor g. Warming from 77°K causes appreciable increases in radical concentration, suggesting that much of the primary radiation damage is nonparamagnetic. Further warming results in a near complete disappearance of all radicals, which is consistent with dimerization occurring in the solid state. (auth) (UK)

35238 PULSE-RADIOLYSIS AND SPECTRAL STUDIES OF THE INTERACTION OF CETYLPYRIDINIUM CHLORIDE AND METHYLENE BLUE WITH CONNECTIVE-TISSUE GLYCOSAMINOGLYCANS AND RELATED COMPOUNDS. Davies, J. V.; Dodgson, K. S.; Moore, J. S.; Phillips, G. O. (Christie Hospital and Holt Radium Inst., Manchester, Eng. University Coll., Cardiff, Wales. Univ. of Salford, Eng.). Biochem. J., 113: 465-71(July 1969).

Hydrated electrons produced by pulse radiolysis were used to study the interaction of polyanionic glycosaminoglycans and related compounds with the counterions of Methylene Blue and cetylpyridinium chloride. The effect of added salt (potassium chloride) on the interaction indicated that the relative binding affinities, with respect to the types of anionic site present, increase for both counterions in the order $CO_3^- < CO_3^- + O \cdot SO_3^- < CO_3^- + O \cdot SO_3^- + N \cdot SO_3^- < O \cdot SO_3^-$. The interactions of the polyanions with cetylpyridinium chloride are considerably stronger than those with Methylene Blue. The effects of added salt on the metachromasia resulting from polyanion–Methylene Blue interaction were examined spectrophotometrically. The collective results demonstrate a direct relationship between anionic site–dye binding and metachromasia, although a residual dye binding can be detected by pulse radiolysis when metachromasia is completely removed. (auth) (UK)

35239 RADIATION-INDUCED SOLID STATE POLYMERIZATION OF ACRYLONITRILE UNDER HIGH PRESSURE. Shu, So-sei; Tabata, Yoneho (Tokyo Univ.). Kobunshi Kagaku, 25: 425-30(July 1968). (In Japanese).

The effect of pressure on the radioinduced solid-state polymerization of acrylonitrile was investigated in a pressure range of 1 to 6000 atm over a temperature range of −196 to −18°C. The rates of polymerization, viscosities, and infrared spectra of polymers obtained were measured. A great difference in polymerization rates above and below the transition temperature in the vicinity of −120°C was observed. The activation energies above the transition temperature are 1.8 kcal/mol for ordinary pressure and 1.4 kcal/mol for 5000 atm, and those below the transition temperature 0.02 kcal/mol for 1 atm, 0.14 kcal/mol for 5000 atm, respectively. The polymerization rate was retarded by pressure in the entire range of polymerization temperature. The polymerization rate was very slow at −78°C, and polymerization did not take place in the solid state at −18°C under a high pressure. It may be due to the formation of a modification of crystal structure at a higher temperature under high pressures above −83°C (the melting point at ordinary pressure). The activation volume at −196°C above 3000 atm was nearly zero, indicating the polymerization under such kind of conditions takes place without any changing of the volume of system. These facts may support the collective excitation mechanism, which was proposed in the polymerization in crystalline state at very low temperatures. (NSA of Japan)

35240 OLIGOMERIZATION OF PROPYLENE AND CRACKING OF CUMENE OVER γ-IRRADIATED SILICA–ALUMINA CATALYSTS. Sano, Masakatsu; Saito, Yoshinori (Hokkaido Univ., Sapporo). Kogyo Kagaku Zasshi, 72: 667-71(Mar. 1969). (In Japanese).

The oligomerization of propylene and the cracking of cumene over γ-irradiated silica–alumina catalysts were investigated. In both the reactions, the activity of the irradiated catalysts increased in spite of the decrease in acidity. No changes in the surface area of the catalyst with irradiation were observed. It was generally believed that the increase in activity of the irradiated catalysts is a result of the increased acidity arising from irradiation. However, in these experiments, the activity of the irradiated catalysts showed no relationship with an acidity for various acid strength in the range of $H_0 \leqq +3.3$. It is also clearly observed from results of hydrogen adsorption and electric conductivity of the irradiated catalysts that the activity of the catalysts mainly depended on lattice defects induced on irradiation. (NSA of Japan)

35241 METHOD OF PREPARATION OF RADIOACTIVE TELLURIUM. (to Japan Atomic Energy Research Inst.). French Patent 1,496,047. Filed Oct. 7, 1966.

A method for preparation of radioactive isotopes of Te comprises dissolving an irradiated actinide containing radioactive Te as a fission product in an aqueous solution of a hydrogen halide or a thiocyanate; introducing a metal selected from the group Ni, Cu, Bi, Hg, and Ag into the solution to effect selective deposition of radioactive Te on the metal; separating the metal from the solution and dissolving the metal and the deposit of Te in an aqueous solution of HNO_3; evaporating the solution to dryness and dissolving the residue in concentrated HCl; raising the temperature of the solution to the boiling point and then diluting the solution so as to obtain a 0.1 to 0.5 N HCl solution passing the solution through a cation exchange resin; and finally washing the resin with 0.1 to 0.5 N HCl and then eluting the radioactive Te from the resin with 1 N HCl. (NPO)

35242 HYDROGEN ION YIELDS IN THE RADIOLYSIS OF NEUTRAL AQUEOUS SOLUTIONS. Cercek, B.; Kongshaug, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Phys. Chem., 73: 2056-8(June 1969).

Results are reported of a γ and electron pulse radiolysis study of deaerated aqueous p-bromophenol solutions in which the hydrogen ion yields were measured. A curve obtained by plotting the concentration of p-bromophenol against $G(H_3O^+_{aq})$ showed that the hydrogen ion yields attained two plateaus, the forst for p-bromophenol concentrations between 3×10^{-3} and 1.2×10^{-2} M, and the second for concentration above 2.2×10^{-2} M. The mean values of the yields in these regions are $G(H_3O^+_{aq}) = 3.40 \pm 2\%$ and $G(H_3O^+_{aq}) = 3.93 \pm 2\%$. When about 90% of the OH and H radicals were scavenged by 1 M 2-propanol solution, $G(H_3O^+_{aq})$ decreased from 3.40 to 2.75. Within the range of doses used the yields of the hydrogen ions were proportional to the radiation doses for both ^{60}Co γ and accelerator irradiations indicating independence of dose rate from 5 RAD sec^{-1} to 30 MRAD sec^{-1}. (D.H.M.)

35243 ON THE NATURE OF THE PRODUCTS OF γ RADIOLYSIS OF AERATED AQUEOUS SOLUTIONS OF BENZENE. Srinivasan, T. K. K.; Balakrishnan, I.; Reddy, M. P. (National Chemical Lab., Poona). J. Phys. Chem., 73: 2071-3(June 1969).

Results of a study of the γ radiolysis of aerated aqueous solutions of benzene, including study of uv and ir spectra, indicate that the product formed along with phenol is β-hydroxymucondialdehyde. (D.H.M.)

35244 APPLICATIONS OF THE SPUR DIFFUSION MODEL TO THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. Schwarz, Harold A. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 73: 1928-37(June 1969).

Recent determinations of absolute rate constants for various free radical reactions made possible detailed predictions from the spur diffusion model for comparison with experimental results on the radiolysis of various aqueous systems. To reduce the required computer time to a reasonable compass, a modified form of the "prescribed diffusion" approximation was developed and was shown to give results agreeing to 1% with those obtained by exact numerical integration of typical cases. The values of five independent parameters required (initial yields of e^-_{aq}, H, and H_2 and mean initial distribution radii for e^-_{aq} and OH) were fixed by adjustment to well-established experimental results on the values of the radical and molecular yields from γ rays at low scavenger concentrations and the variation of the molecular yields with concentration of added nitrite ion. Predictions were then made on the yield of nitrogen gas in nitrous oxide solutions, the effect of added acid on the reduction of the molecular hydrogen yield by nitrate ion and by hydrogen peroxide, the effect of pH on the isotope separation factor for hydrogen production in water containing HDO, and the rate of decay of the solvated electron over a period of several nanoseconds following a 3-nsec pulse of radiation. In all cases, the predictions, made without introducing any new parameters, agreed well with published experiments, although these results had been thought possibly to disagree with the spur diffusion theory. The results show that about one-third of the molecular H_2 arises from processes other than spur reactions and that the electron is hydrated at an average distance of 23 Å from the center of the spur. (auth)

35245 RADICAL AND MOLECULAR YIELDS IN WATER IRRADIATED BY γ RAYS AND HEAVY IONS. Appleby, A.; Schwarz, Harold A. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 73: 1937-41(June 1969).

Nitrous oxide solutions containing separately ethanol, sodium deuterioformate, or potassium nitrite were irradiated with ^{60}Co γ rays, 18-MeV deuterons, and 32- and 12-MeV helium ions in order to obtain the variation of the hydrated electron yield, the hydrogen atom yield, and the molecular hydrogen yield with the linear energy transfer (LET) of the radiation. It was found that the hydrogen atom yield does not increase with LET as the molecular hydrogen does nor does it decrease as rapidly as the

electron yield. The results are compared with the diffusion model of spurs and tracks and are in agreement with the previous conclusion that hydrogen atoms are produced both by direct action on the water and by reaction of the hydrated electrons with hydrogen ion in the tracks. The much smaller perhydroxyl radical yield was also measured for these particles in copper sulfate–ferrous sulfate solutions. (auth)

35246 CHARGE-TRANSFER COMPLEXES AS RADIOLYTIC PRODUCTS FROM ALKYL HALIDES AND TOLUENE IN ALKANE MATRICES AT 77°K. Louwrier, Pieter W. F.; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 73: 1707-11(June 1969). (COO-38-639).

Gamma-irradiated systems of C_6H_6 or $C_6H_5CH_3$ in a matrix of CCl_4 at 77°K exhibit absorption bands at ~500 nm, not present for the same additives in a matrix of 3-methylpentane (3MP), which can be attributed to charge-transfer complexes Al–Cl. When both $C_6H_5CH_3$ and 2-C_3H_7Br are present in 3 MP, bands at 500 and 675 nm appear which are not present with either additive alone. The 500-nm band is attributed to $C_6H_5CH_3 \cdot Br$ because it increased as $C_6H_5CH_3^+$ absorption decreased. The 675-nm band is attributed to $C_6H_5CH_3 \cdot C_3H_7Br^+$ because its decay is coupled with increased absorption by $C_6H_5CH_3^+$. For 2-C_3H_7Br alone in 3MP, bands appear at 600, ~400, 360, and 260 nm. By analogy with alkyl iodides in 3MP the dominant band in dilute solutions (400 nm) is attributed to $PrBr^+$, and the strong band at high concentration (360 nm) to $(PrBr)_2^+$ from preexisting neutral dimer. Isothermal decay of these species enhances the 600-nm band, attributed to $PrBr^+ + Br^- \rightarrow PrBr \cdot Br$. The band at 260 nm behaved very differently and may be due to Pr. (auth)

35247 ELECTRON PARAMAGNETIC RESONANCE EVIDENCE FOR THE PRESENCE OF ALUMINUM AT ADSORPTION SITES ON DECATIONATED ZEOLITES. Wang, Katherine M.; Lunsford, Jack H. (Texas A and M Univ., College Station). J. Phys. Chem., 73: 2069-71(June 1969).

The EPR spectra of the superoxide ion, O_2^-, was used to study the magnetic interaction between an adsorbed paramagnetic species and an aluminum nucleus in order to demonstrate whether Al is part of an absorption site. The spectra of O_2^- was observed at 77°K when a decationated Y zeolite was γ-irradiated in the presence of oxygen. The spectra observed at 77°K when the sample had been heated at temperatures of 150 to 250°C for 30 minutes to 24 hrs can be resolved into 3 sets of 6 hyperfine lines. The O_2^- spectra is characterized by $g_{xx} = 2.009 \pm 0.001$, $g_{yy} = 2.002 \pm 0.001$, and $g_{zz} = 2.038 \pm 0.001$ with $|a_{xx}| = 4.7 \pm 0.5$ G, $|a_{yy}| = 5.7 \pm 0.5$ G, and $|a_{zz}| = 6.5 \pm 0.5$ G. When O_2 was not present in the sample tube, the spectrum of the γ-irradiated decationated zeolite exhibited only a weak single peak with a g value of 2.0017. It appears that the 3 sets of 6 hyperfine lines occur because of the interaction between ^{27}Al nucleus ($I = 5/2$) and the unpaired electron of O_2^-. (D.H.M.)

35248 RADIOLYSIS OF VINYL IODIDE. PART 3. FORMATION OF POLYMER IN CARBON TETRACHLORIDE SOLUTIONS. Herman, Jan A.; Roberge, Pierre C. (Laval Univ., Quebec). Trans. Roy. Soc. Can., 65: 1315-24(May 1969).

The polymerization of vinyl iodide in carbon tetrachloride solutions by ^{60}Co gamma rays was studied. The infrared spectrum of the polymer shows the existence of a CCl_3 group per macromolecule independently of the monomer concentration in solutions from which the polymer is formed. Moreover, the polymerization shows a relatively constant molecular weight, around 7500, a negative temperature coefficient, and an intensity exponent of ~1.0. It is assumed that initiation of polymerization is due to hot CCl_3 radicals or CCl_3^+ ions, while termination is by deactivating transfer on solvent and on monomer. (auth) (UK)

35249 RADIOLYSIS OF VINYL IODIDE. PART 2. SOLUTIONS OF VINYL IODIDE IN CARBON TETRACHLORIDE. Roberge, Pierre C.; Herman, Jan A. (Laval Univ., Quebec). Trans. Roy. Soc. Can., 65: 1303-14(May 1969).

Radiolysis of solutions of vinyl iodide in carbon tetrachloride enables a mechanism of formation of products to be specified. Ethylene is formed in spurs in reactions involving vinyl radicals and hydrogen iodide, while acetylene is formed in three different processes involving molecular decomposition of vinyl iodide, and hydrogen-abstraction reactions by either iodide or chlorine atoms from vinyl radicals. Hydrogen iodide is formed in hydrogen-abstraction reaction by atomic iodine from vinyl radical. Hydrogen is formed in the molecular decomposition and by hot hydrogen atom abstraction. Hydrogen chloride is formed mainly by hot chlorine atom abstraction of hydrogen from vinyl iodide. Competition between the dissociative electron attachment processes of CCl_4 and C_2H_3I strongly affects the hydrogen chloride formation. Vinyl chloride is formed in spurs in reactions involving vinyl radicals and HCl or Cl atoms. There is no evidence of electronic excitation transfer in the system, and charge transfer seems improbable. (auth) (UK)

35250 METHOD OF PREPARATION OF ^{137}Ba. (to Societe Saint-Gobain Techniques Nouvelles). French Patent 1,470,335. Filed Dec. 23, 1965.

A method is described for the preparation of ^{137}Ba from ^{137}Cs, which is fixed on an ion exchange resin. The resin is contacted with an aqueous phase, preferably a 2M $NaNO_3$ containing a buffer, preferably of the citric acid–Na_2HPO_4 type, which maintains the pH in the range 4.0 to 4.5, and the resin is eluted with an organic phase in an inert solvent, and is equilibrated with the aqueous phase of the proper pH prior to elution. Preferably a small quantity of TBP is added to the organic phase [bis(2-ethylhexyl) phosphate] to facilitate the dissolution of the Na salt, thus clarifying the phase, and a small amount of cemulsol K is added to the aqueous phase to facilitate the substitution of the aqueous phase by the organic phase. (NPO)

Radiochemistry

Refer also to abstracts 35508 and 36232.

35251 (RFP-1098) COMPUTER PROGRAM FOR DETERMINING THE GROWTH OF NUCLIDES FROM RADIOACTIVE DECAY. Forrey, Charles R. Jr. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Mar. 25, 1969. Contract AT(29-1)-1106. 54p. Dep. CFSTI.

A computer program was written for extrapolating the quantities of nuclides that are or will be present in radioactive material previously analyzed for isotopic content by radiochemical methods. The modified Isogen (Isotope Generation) computer program can be used to determine the change in isotopic concentration of an element; hence, to determine the specific activity over extended periods of time. It can also be used to determine procedures necessary to analyze for any particular element and to determine if nuclides or elements are present in detectable quantities. It can also predict the isotopic concentration and impurity content of the final product at any given time in the future. (auth)

35252 PREPARATION OF ^{137}Ba IN AN ORGANIC MEDIUM. Bonnin, Andre; Poirier, Philippe (to Societe Saint-Gobain Techniques Nouvelles). U. S. Patent 3,450,640. June 17, 1969. Priority date Dec. 23, 1965, France.

Barium-137 is obtained from ^{137}Cs fixed on an ion exchange resin. The ^{137}Cs fixed on the ion exchange resin is contacted with a buffered aqueous phase and the resin is then eluted with an organic phase. The ^{137}Ba is extracted from the aqueous phase film on the resin. (Offic. Gaz.)

35253 LONG-LIVED GAMMA ACTIVITY OF FISSION PRODUCTS IN A URANYL SULFATE SOLUTION. Voinov, A. M.; Kul'gavchuk, V. M.; Maslov, G. N.; Nasyrov, F. Kh.; Pashkin, N. F.; Samodurov, L. A. At. Energ. (USSR), 26: 380-1(Apr. 1969). (In Russian).

A solution of uranyl sulfate was used in a critical assembly. After decay of 338 and 488 days the solution was mixed carefully, and samples were taken for scintillation counting of the solution and of the precipitate. The ^{137}Cs peak was of the greatest interest for determining the amount of fission energy imparted to the solution. By calibrating the sodium iodide crystal it was possible to determine the absolute activity of the peaks in the solution and in the precipitate. Zirconium-95 or ^{95}Nb were found to concentrate in the precipitate. The ^{137}Cs peak could clearly be distinguished in the solution. A total of 5.9×10^{15} fissions per gram of ^{235}U was found from the measured gamma activity of ^{137}Cs. This amount represented 80% of the energy given off during operation. Since the error in determining the amount of energy given off was about 15%, the result can be considered as satisfactory. (TTT)

Separation Processes

Refer also to abstracts 34989, 34998, 35019, 35060, 35063, 35098, 35122, 35128, 35130, 35252, 35793, 36067, 36276, 37444, 37448, and 37513.

35254 (ANL-Trans-756) CONTRIBUTION TO THE SEPARATION OF RARE EARTHS BY EXTRACTION CHROMATOGRAPHY WITH DI(2-ETHYLEHEXYL) PHOSPHORIC ACID (HDEHP). I. SILICA GEL AS A SUPPORT MATERIAL FOR THE STATIONARY PHASE. Herrmann, Eckhard. Translated for Argonne National Lab., Ill., from J. Chromatogr., 38: 498-507(1968). 12p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 7612.

35255 (BNWL-1074) FIXATION OF RADIOACTIVE RESIDUES. Research and Development Activities, Quarterly Progress Report, February-April 1969. Blasewitz, A. G. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 39p. Dep. CFSTI.

Approximately 4,000,000 Ci of radioactivity were successfully processed in two spray solidification runs in WSEP. Spray Solidification Run SS-8 was made using a simulated Purex Waste 1 (PW-1) feed while SS-9 was made using a simulated Purex Waste 4m (PW-4m) feed. This was the first radioactive demonstration of the PW-4m flowsheet; a relatively clean waste with an exposure of 45,000 MWd/tonne at 30 MW/tonne. Spray solidifier performance during solidification of the PW-4m flowsheet was excellent. Simulated PW-4m spray feeds suitable for use in the WSEP were successfully tested in the development spray solidifier. Feed additives of iron, sodium, lithium, and phosphate produced melts giving a volume reduction of eight from solidifying PW-4m at an equivalent 378 liters/tonne. Ruthenium volatilization from low acid PW-4m feed was suppressed by adding solid $NaPO_3$ flux to calcine in the development melter. The resulting melt in laboratory tests, however, contained a nonmelting rare earth phase that could plug the melter drain valves. Laboratory tests with PW-4m showed that melting points were lowered as much as 50°C as the M/P ratio was decreased from 2.75 (the successfully used ratio for both PW-1 and PW-2) to 2.25. The tendency for phase separation in the product was greater at the lower ratio, therefore a compromise of 2.5 was selected for WSEP Run SS-9. Thermal conductivity and dispersibility data for samples of nonradioactive PW-2 phosphate glass showed definite improvement for both these characteristics for samples stored at 600°C as compared to those stored at 100°C. (auth)

35256 (CEA-R-3585). SEPARATION OF RADIOCESIUM USING POTASSIUM AND COBALT FERROCYANIDES. APPLICATION TO RADIOACTIVE WASTE AND SEA WATER. Scheidhauer, Jean; Vergnaud, Gerard; Flamant, Andre (Commissariat a l'Energie Atomique, la Hague (France)). Sept. 1968. 11p. (In French). Dep.

Radiocesium was separated by ion-exchange on cobalt and potassium ferrocyanides. The factors studied, and which could affect this separation include: pH; amount of ion-exchanger used; rate of flow of the sample; grain-size of the ion-exchanger; and selectivity. The operational technique used is described, as well as its particular application to sea-water. The method was found to be simple and rapid with selectivity and yield very satisfactory. (auth)

35257 (IN-1153) URANIUM RECOVERY FROM ALUMINUM ALLOYED FUEL AT ICPP DURING FISCAL YEAR 1966. Palica, W. P.; Gold, M. D. (Idaho Nuclear Corp., Idaho Falls). June 1969. Contract AT(10-1)-1230. 20p. Dep. CFSTI.

Highly enriched uranium-aluminum alloyed fuels containing 426.6 kg of uranium were processed at the Idaho Chemical Processing Plant during fiscal year 1966 using a continuous nitric acid dissolution step followed by one tributyl phosphate and three Hexone extraction cycles. The uranium recovery was 99.74%, and the overall fission product decontamination was excellent. Gelatin was added (0.1 g/l) and the acidity of the first-extraction cycle feed was increased to 2.4M to reduce emulsions and minimize uranium losses. The feed tended to form stable emulsions because feed evaporation was not used. Solids also were troublesome in the first-extraction cycle. High waste volume, approximately double the rate achieved during the previous campaign, resulted due to the out-of-service first-cycle waste evaporator and to the short processing times. Approximately 300 grams of neptunium were recovered with high yields using chromic acid for valence shifting during this campaign instead of the ferrous sulfamate used previously. (auth)

35258 (INP-674) INVESTIGATION ON THE SEPARATION OF SOME LANTHANIDES AND ACTINIDES BY EXTRACTION CHROMATOGRAPHY IN THE SYSTEM DI-(2-ETHYLHEXYL)-ORTHOPHOSPHORIC ACID-HYDROCHLORIC ACID. Stronski, Ignacy (Institute of Nuclear Physics, Krakow (Poland)). Jan. 1969. 18p. (In German). Dep.

The extraction and reextraction processes of some chlorides of lanthanides and actinides were investigated by partition chromatography. Chromatographic columns with powdered polytrifluoromonochloroethylene (KEL-F) supporting bis(2-ethylhexyl) othophosphate (HDEHP) were used. The optimal conditions of separation of trace amount of trivalent (or divalent) ions of Eu-Gd, Eu-Tb, Ho-Er, Tm-Lu, Yb-Lu as well as Am-Eu, Am-UO_2, and Am-PuO_2 were found. The influence of irradiation on the solid supports and extractant with γ quantums of ^{60}Co nuclides were also studied. (auth)

35259 (INP-675) SOLVENT EXTRACTION AND SEPARATION OF SOME LATHANIDES AND AMERICIUM BY EXTRACTION CHROMATOGRAPHY IN THE SYSTEM ALIQUAT-336-$LiNO_3$ AND HNO_3. Stronski, Ignacy (Institute of Nuclear Physics, Krakow (Poland)). Jan. 1969. 15p. Dep.

The liquid-liquid extraction of La, Nd, Eu, Ho, and Am nitrates by means of the radiotracer method in the system tricaprylmonomethyl ammonium nitrate (Aliquat-336)-lithium nitrate and nitric acid was investigated. The mixture of tracer quantities of Eu-Am, Nd-Pr, Sm-Pm, Gd-Eu, Er-Ho, Tm-Er, Yb-Tm, and Lu-Tm were separated by column partition chromatography. (auth)

35260 (ORNL-4234) UNIT OPERATIONS SECTION QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1967. Whatley, M. E.; Haas, P. A.; McNeese, L. E., Ryon, A. D.; Suddath, J. C.; Watson, C. D. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 96p. Dep. CFSTI.

Research progress is reported under the following headings: stacked-clone contactor, engineering separation of biological macromolecular substances, sol-gel process development, thorium fuel-cycle studies, and molten-salt reactor processing studies. (M.C.G.)

35261 PROCESS FOR THE RECOVERY OF URANIUM CONTAINED IN SOLUTIONS OF HALOGEN FLUORIDES. (to Commissariat a l'Energie Atomique). French Patent 1,464,912. Filed Nov. 26, 1965.

Uranium was recovered from solutions of halogen fluorides by hydrolyzing the fluorides by contacting them in the liquid phase with water, eliminating the volatile halogens, and recovering the U from the resulting aqueous solution of uranylfluoride in a known manner. Preferably the hydrolysis is effected by directing a liquid jet of the U-containing halogen fluorides against the free surface of a large volume of water. (NPO)

35262 SEPARATION OF ISOTOPIC METHANES BY GAS CHROMATOGRAPHY. Bruner, Fabrizio; Cartoni, G. Paolo; Possanzini, Massimiliano (Univ., Rome). Anal. Chem., 41: 1122-4(July 1969).

The separation, on adsorption glass capillary columns, of all isotopic methanes (either when the substitution takes place on the carbon atoms or when the hydrogen is partially or completely substituted by deuterium or tritium) is reported. Mixtures of partially deuterated methanes were prepared by x irradiation of a mixture of D_2, Xe, and CH_4. Applications for the gas chromatographic separation of isotopic methanes are the purity control of various isotopic molecules, the possibility of studying the kinetics of isotopic exchange reactions, and the determination of the monodeuterated methane in natural methane. (D.H.M.)

35263 PROCESS FOR THE SEPARATION OF MOLYBDENUM FROM FISSION PRODUCT CONTAINING SOLUTIONS. Maria, Alain; Patigny, Pierre; Perie, Daniel (to Commissariat a l'Energie Atomique). U. S. Patent 3,450,639. June 17, 1969. Filed Feb. 20, 1967.

A process was developed for the separation of Mo from solutions, especially HNO_3 solutions containing fission products and derived from the processing of irradiated U-Mo fuels. Phosphoric acid is added to HNO_3 solutions containing fission products; with the quantity of H_3PO_4 being sufficient to effect total complexing of the Mo in the form of a phosphomolybdic complex. The fission product solutions are contacted with an organic phase constituted by trilaurylamine, which may be diluted and which serves to extract the phosphomolybdic complex. The complete process is carried out in a bank of mixer-settlers. The volumes of aqueous phase and organic phase that are contacted in a proportion of approximately 1:4 and the contacting times are of the order of one minute. (Offic. Gaz.)

35264 MODERN METHODS FOR THE SEPARATION OF RARER METAL IONS. Korkisch, J. Oxford, Pergamon Press, 1969. 632p. 150s.

Separation methods are described for the following elements, based on ion exchange, chromatography, liquid-liquid extraction, distillation, and coprecipitation: Actinides; rare earths; lithium; rubidium, cesium, and francium; beryllium; radium; gallium; indium, and thallium; germanium; selenium, tellurium, and polonium; silver; gold; titanium; zirconium and hafnium; vanadium; niobium and tantalum; molybdenum and tungsten; technetium and rhenium; and platinum metals. (UK)

35265 SELECTIVE REDUCTION OF PuF_6. Manevy, Georges (to Commissariat a l'Energie Atomique). U. S. Patent 3,450,509. June 17, 1969. Priority date Dec. 1, 1966, France.

Selectively reducing PuF_6 present in a mixture containing PuF_6, UF_6, and eventual fission products, is accomplished by mixing the mixture of hexafluorides with a proportion of CO_2 more than that stoichiometrically necessary and maintained at about 350°C at a pressure of between 0.5 and 3 bars for a time sufficient for com-

plete reduction of PuF_6. The process may be carried out either continuously by flowing the mixture through a vertical reaction vessel or in batches. (Offic. Gaz.)

35266 URANIUM ORE PROCESSING. Smith, S. E.; White, P. A. Eng. Mining J., 170: 113-15(June 1969).

Future needs of uranium and possible methods of meeting those needs economically are considered. Research is seen as the tool for improvement of the following methods of ore processing: physical upgrading; electrohydraulic crushing; chemical leaching; bacterial leaching; and, solution mining, or underground leaching. (J.G.B.)

35267 MAZINGARBE HEAVY WATER PLANT. Nucl. Eng. Int., 14: 578-80(July 1969).

The history and principles of the process which produces heavy water as a by-product of a large NH_3 synthesis plant are outlined. A description is given of the stages of purification, isotopic exchange, catalyst recovery, and finishing. Brief reference is made to pumps and compressors. (UK)

35268 REVERSED-PHASE PARTITION CHROMATOGRAPHIC SEPARATIONS WITH 2-ETHYLHEXYL DIHYDROGEN PHOSPHATE AND DI-2-ETHYLHEXYL HYDROGEN PHOSPHATE. Lyle, S. J.; Nair, V. C. (Univ. of Kent, Canterbury, Eng.). Talanta, 16: 813-21(July 1969).

Di-2-ethylhexyl hydrogen phosphate (HDEHP) and 2-ethylhexyl dihydrogen phosphate (H_2MEHP) were compared as stationary phases in reversed-phase chromatography of selected lanthanides, strontium, yttrium, barium, manganese(II), iron(III), cobalt(II), nickel, gold(III), platinum(IV), palladium(II), and silver. Chromatograms were mainly developed with hydrochloric acid at various concentrations. In general H_2MEHP was found to be less satisfactory than HDEHP. Development of chromatograms by dilute aqueous electrolytes on paper was slower and separations of chemically similar metals such as lanthanides were not encouraging. Movement of lanthanides by EDTA at pH 3 in an aqueous sodium perchlorate medium occurred only on H_2MEHP-treated paper, however good separations of iron(III) and cobalt(II) were possible on paper treated with either ester, and gold(III) and platinum(IV) were separated on HDEHP-impregnated paper. Column methods for the separation of carrier-free ^{99}Au and ^{59}Fe from macro-amounts of neutron-irradiated platinum and cobalt, respectively, were developed. (auth) (UK)

35269 LICENSING OF REPROCESSING PLANT OPERATORS. Brooksbank, R. E. (Oak Ridge National Lab., Tenn.).; Skovolt, D. E.; Lewis, W. H. Trans. Amer. Nucl. Soc., 12: 23-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35270 CHEMISTRY RELATING TO A REDUCTIVE-EXTRACTION PROCESS FOR MSBR FUELS. Ferris, L. M. (Oak Ridge National Lab., Tenn.); Mailen, J. C.; Lawrance, J. J.; Smith, F. J.; Nogueira, E. D. Trans. Amer. Nucl. Soc., 12: 26-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35271 DEMONSTRATION OF $^{233}UO_2$–ThO_2 MICROSPHERE PRODUCTION BY THE SOL-GEL PROCESS. Parrott, J. R.; Daley, F. L.; Furman, J. T.; Snider, J. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 27-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35272 HEAVY-ELEMENT PARTITIONING BY EXTRACTION (HEPEX). Weaver, Boyd (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 55(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35273 PREPARATION OF ^{244}Cm–^{243}Am OXIDE MICROSPHERES BY A SOL-GEL METHOD. Vaughen, V. C. A.; Hoeschele, J. D.; Lloyd, M. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 55-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35274 EVALUATION OF CENTRIFUGAL CONTACTORS. Orth, D. A.; McKibben, J. M. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 28(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35275 THE PREPARATION OF CONCENTRATED URANIA SOLS BY SOLVENT EXTRACTION. McBride, J. P.; McCorkle, K. H.; Pattison, W. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 206(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35276 CHARACTERIZING PLUTONIUM ACCUMULATIONS. Forstner, J. L.; McKibben, J. M.; Orth, D. A. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 337-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35277 INCREASING MAXIMUM ENRICHMENT PROCESSING CAPABILITY THROUGH CRITICALITY CALCULATIONS. Dunaway, D. L. (National Lead Co. of Ohio, Cincinnati); Johnson, W. A. Trans. Amer. Nucl. Soc., 12: 339(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35278 CRITICALITY CONTROL IN LARGE SPENT-FUEL DISSOLVERS USING HOMOGENEOUS POISON. Brunnenmeyer, Richard L. (Bechtel Corp., San Francisco, Calif.). Trans. Amer. Nucl. Soc., 12: 339-41(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35279 SOL-GEL PROCESS: PLUTONIA AND PLUTONIA–URANIA FOR SPECIAL AND NUCLEAR APPLICATIONS. McDuffee, W. T.; Lloyd, M. H.; Bond, W. D.; Tallent, O. K. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 105(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35280 CENTRIFUGE FOR PURIFYING LIQUID SODIUM. Matte III, J.; Toth, W. L. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 12: 123-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35281 ION EXCHANGE RESINS FOR URANIUM HYDROMETALLURGY. Kunin, Robert; Gustafson, Richard L.; Isacoff, Eric G.; Filling, Henry F. (Rohm and Haas Co., Philadelphia). Eng. Mining J., 170: No. 7, 73-9(July 1969).

Results of a study comparing the uranium hydrometallurgical performance of a quaternary ammonium anion exchange resin with that of a tertiary amine anion exchange resin indicate that the latter has several advantages with respect to both elution costs and purity of uranium product, particularly with respect to the major impurity, iron. As the uranium ore reserves require the processing of lower grade ores, the use of a tertiary amine anion exchange resin as described will be preferred over quaternary ammonium anion exchange resins and liquid anion exchangers. From a basic knowledge of such ion exchange resins, it can be predicted that the tertiary amine anion exchange resin would be less susceptible to poisoning by such materials as polythionates, cobalticyanides, organic matter, etc. (auth)

35282 ISOTOPIC CHEMICAL REACTION USED IN SEPARATION OF ^{15}N. Axente, D. (Institutul de Fizica Atomica, Cluj). Stud. Cercet. Chim., 17: 79-105(Feb. 1969). (In Rumanian).

The isotopic chemical reaction used in the separation process of natural ^{15}N in exchange columns is described. The mechanism of chemical exchange of ^{15}N between the systems: $NO-HNO_3$, $NO-N_2O_3$, $NH_3-NH_4^+$, and other systems was studied. (R.V.J.)

35283 SYNERGIC SOLVENT EXTRACTION OF RARE EARTHS. I. SPECTROPHOTOMETRIC INVESTIGATION OF HOLMIUM- AND ERBIUM-TTA-TOPO COMPLEXES WITH PERCHLORATE ION. Takatatsu, T.; Toriumi, N. (Kyushu Univ., Fukuoka). J. Inorg. Nucl. Chem., 31: 2235-46(July 1969).

The synergic solvent extraction behavior of holmium and erbium in Ln^{3+}/ClO_4^-/HTTA/TOPO systems was investigated spectrophotometrically. The formulas of these complexes were estimated to be $(Ln(TTA)_3(TOPO)_2)^+ClO_4^-$, which gave a strong band with a maximum of 445 mμ for holmium and 518 mμ for erbium, and showed a considerable electric conductivity in a polar organic solvent. When the rare earth was completely extracted into the organic layer, the following equation was assumed: $Ln(TTA)_3(TOPO)_2 + 3TOPO + H^+ + ClO_4^- \rightleftharpoons (Ln(TTA)_3(TOPO)_2)^+ ClO_4^- + HTTA$ for which the mixed equilibrium constant is defined by $k_3 = [(Ln(TTA)_3(TOPO)_2)^+ClO_4^-][HTTA]/[Ln(TTA)_3(TOPO)_2][TOPO]^3[H]^+[ClO_4^-]$. The log k_3 increases linearly with increase in the dielectric constant of the organic solvent used. The discrepancy in the distribution coefficient of rare earths between ClO_4^-/HTTA/TOPO and Cl^-/HTTA/TOPO systems also increases with increase in the dielectric constant. (auth) (UK)

35284 A TETRAD EFFECT IN THE LIQUID–LIQUID EXTRACTION ORDERING OF LANTHANIDES(III). Peppard, D. F.; Mason, G. W.; Lewey, S. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 31: 2271-2(July 1969).

It has been argued that a discontinuity in properties should oc-

cur at Gd (Z = 64), which is the middle member of the rare earth series (Z = 57 to 71), due to a predicted "half-filled" shell effect with reference to the electronic structure of the trivalent ion. The observed point of division is somewhat indefinite and varies with regard to the property considered. Data on solvent extraction have been presented in terms of two octads of elements with Gd common to both. Studies are described, however, suggesting that in certain liquid–liquid extraction systems the behavior of lanthanides(III) is preferably interpreted in terms of four tetrads, with Gd common to the two central tetrads. The tetrad effect was evident in a plot of log K/Z, four separate curves being obtained, with the two central curves having Gd as a common member. An unusual placement of Y may show promise for effecting Y purification and it is believed that this is the first reported system in which Y does not function as a pseudo-lanthanide with respect to ordering. The tetrad effect has been found in a variety of fundamentally different systems, including those utilizing phosphorus-based extractants of neutral, mono-acidic and di-acidic types, and high molecular weight amines as extractants. The relative behavior of Am and Cm appears to parallel that of their lanthanide analogues. If the tetrad hypothesis is correct, the "half-filled" shell would be joined by "one-quarter filled" and "three-quarters filled" shell effects, the discontinuities occurring between the third and fourth and the tenth and eleventh 4f electron additions. (UK)

35285 REVIEW OF URANIUM ORE PROCESSING RESEARCH. Smith, S. E.; White, P. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Aust. Mining, 61: 50-4(Apr. 15, 1969).

Extraction recovery techniques for marginally economic ores of U are considered and possible research topics are outlined. In the usual extraction flowsheet the target areas for research are ore upgrading by lump sorting or benefication, and the costly leaching process. There is some incentive to develop direct extraction from the slurry. The state of plant operation and research in each main producing country is briefly given. Individual processes are reviewed. The extent and nature of further improvements are likely to be fairly small but the resultant savings could offset rising costs and the need to process lower grade ores. Improvements from use of existing knowledge are likely to be the introduction of Aerofall and autogenous grinding mills, improved leach circuits and use of pressure leaching, solvent extraction purification, some automatic control, improved lump sorters, and the use of bacterial leaching as an adjunct to the main mill process. Areas for further research include complete bacterial leaching, improved upgrading of ore, and complete automation of mill processes. Such improvements could be incorporated in the next generation of mill plants after 1972. (Australia)

35286 MINERAL ION EXCHANGERS ABEDEM AND THEIR IMPORTANCE FOR REPROCESSING OF NUCLEAR FUELS. Beaudet, C.; Cremer, J.; de Maere, G. (SERAI, Brussels). Atompraxis, 15: 165-7(May–June 1969). (In French).

The preparation technique and the properties of two mineral ion exchangers, tin phosphate and titanium phosphate, are described. A particularly promising application of titanium phosphate, the retrieval of cesium from reprocessing solutions of nuclear fuels, is presented. Other applications of mineral ion exchangers are also mentioned. (auth)

35287 ON BEHAVIOR OF Pa(V) AND ITS CHEMICAL ANALOGUES IN STRONG ALKALINE TARTARIC SOLUTIONS. Pal'shin, E. S.; Palei, P. N.; Ivanova, L. A. At. Energ. (USSR), 26: 297-9(Mar. 1969). (In Russian).

Coprecipitation of Pa and its chemical analogs (Nb, Zr, and Ta) from alkali tartaric solutions on various precipitates in the presence of hydrogen peroxide was studied. The most effective coprecipitation of ^{233}Pa from alkali tartaric solutions in various carriers in the presence of hydrogen peroxide was achieved with Th and Ba peroxides while Ba and Ca carbonates precipitated only part of the element. The results showed that Pa reaction in tartaric solutions containing alkali differed significantly from reactions of Nb, Ta, Zr, and other elements. Thus, the method can be used for separating Pa traces from macroquantities of its chemical analogs. (R.V.J.)

35288 CHEMICAL FRACTIONATION OF URANIUM ISOTOPES. Rutenberg, A. C.; Drury, J. S. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 31: 2289-95(Aug. 1969).

Precise measurements were made of the chemical fractionation of ^{235}U and ^{238}U between several forms of U(IV) and U(VI) salts. The observed separation factors were very much smaller than previously supposed. It is shown that the chemical exchange method of isotope separation is unlikely to be economically or technically useful. (auth) (UK)

35289 PROCESS FOR THE REGENERATION OF NUCLEAR FUEL. (to Gelsenkirchener Bergwerk-Aktien-Gesellschaft). French Patent 1,453,639. Filed Nov. 12, 1965.

A nuclear fuel is regenerated by introducing the fuel into a chemical solvent after it has been divided into fragments having a diameter of 2 to 10 mm. The fuel is separated from the sheath and divided by axially drilling the fuel element with the fragments of the fuel being carried off by a circulating liquid. In a modification the fuel and the sheath are both divided into fragments, the materials of the fuel and the sheath being separated afterwards by chemical means. (NPO)

35290 PROCESS FOR DECANNING NUCLEAR FUEL ELEMENTS. (to United Kingdom Atomic Energy Authority). French Patent 1,452,479. Filed Nov. 2, 1965.

A process for removing a metal sheath enclosing a metal nuclear fuel member comprises expanding the sheath away from the fuel member by passing a high frequency alternating current through the sheath so that the temperature of the sheath is raised relative to that of the fuel member, and removing the dilated sheath, e.g., by ultrasonic means or by flexibly mounted, non-metallic or insulated scrapers or shredders. (NPO)

35291 PROCESS FOR THE SEPARATION OF MOLYBDENUM IN SOLUTION. Maria, Alain; Patigny, Pierre; Perie, Daniel (to Commissariat a l'Energie Atomique). British Patent 1,156,366. June 25, 1969. Priority date Dec. 30, 1965, France.

Molybdenum is separated from nitric acid solutions containing fission products and obtained after extraction of U and Pu from irradiated U–Mo fuels by adding phosphoric acid to completely complex all the Mo as the phosphomolybdic complex and simultaneously contacting the solution with a solution of trilaurylamine or one of its salts to extract the complex. (B.L.M.)

35292 METHOD OF PLUTONIUM REDUCTION. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,156,044. June 25, 1969. Priority date Oct. 9, 1965, Germany.

Plutonium is reduced to Pu(III) in either aqueous or organic solutions by the addition of a nitrite and the proper amount of acid. The separation of U and Pu is achieved in the reprocessing of nuclear fuels by the solvent extraction of both U and Pu(IV) followed by the reduction of Pu to Pu(III) by the addition of sodium nitrite, which forces the Pu(III) into the aqueous phase. Uranium is then extracted from the organic solution with 0.02 M HNO_3. (B.L.M.)

35293 PROCESSING OF IRRADIATED NUCLEAR FUELS. (to United Kingdom Atomic Energy Authority). French Patent 1,404,016. Filed July 8, 1964.

A process is described for the separation of nuclear fission products into four groups comprising: (1) Ru, Cs, Ba, Sr, (2) rare earth metals except Ce, (3) Ce, and (4) Zr and Nb. An aqueous solution of the fission products that is 0.005 to 0.1 N in HCl is contacted with a 0.5 to 2.0 M solution of bis(2-ethylhexyl) ester of phosphoric acid in a saturated aliphatic or aromatic hydrocarbon, preferably hexane, so as to form an aqueous phase containing group (1) and an organic phase containing groups (2), (3), and (4). The organic phase is washed with an aqueous 7 to 11 N HNO_3 containing 0.1 to 1.0 M $NaBrO_3$ to extract group (2) and then with aqueous 4 to 10 N HCl containing 1 to 10% H_2O_2 to extract group (3) with group (4) remaining in the organic phase. If desired group (1) may be separated into its components. To separate the Cs the aqueous phase is made alkaline by adding sufficient NaOH to make it 0.1 N with respect to NaOH and then contacted with a 0.01 M solution of dipicrylamine in nitrobenzene to extract the Cs, which may be recovered from this solution by scrubbing with an equal volume of 1 N HCl. To separate the Sr and Ba the aqueous phase is made slightly acidic (pH 4 to 5) and then contacted with a 0.4 M solution of bis(2-ethylhexyl) ester of phosphoric acid in hexane to extract the Sr and Ba, which may be recovered from this solution by scrubbing out with 0.1 N HCl and separated from each other by precipitation methods. If only Zr is required to be separated from the fission products the original solution is made 1 to 3 N in HNO_3 and 0.5 to 2.0% in H_2O_2 and then extracted with a solution of bis(2-ethylhexyl) ester of phosphoric acid in hexane from which it may be removed by dilution with toluene and stripping with a 3 to 5 N aqueous solution of HF. (NPO) (UK)

35294 METHOD OF EXTRACTING MOLYBDENUM VALUES FROM AN AQUEOUS NITRIC ACID SOLUTION. (to Commissariat a l'Energie Atomique). French Patent 1,469,204. Filed Dec. 30, 1965.

A method is described for extracting Mo values as the phosphomolybdic complex from an aqueous HNO_3 solution resulting from the processing of irradiated nuclear fuel materials after the removal of the U and Pu values. After the addition of at least a stoichiometric quantity of H_3PO_4 for transforming all of the Mo

into phosphomolybdic acid, the complex is extracted at a temperature of about 40°C into an organic phase consisting of trilaurylamine or one of its salts, preferably mixed with a diluent. After extraction, the organic phase is contacted with an alkaline aqueous solution to re-extract the Mo. (NPO)

35295 METHOD OF EXTRACTING METHYL IODIDE FROM GASEOUS FISSION PRODUCTS. (to United Kingdom Atomic Energy Authority). French Patent 1,487,919. Filed July 27, 1966.

A method of extracting CH_3I from fission gases comprises passing the gases through a bed of activated carbon, impregnated with HI, FeI_2, NiI_2, or an iodide of an alkaline earth or an alkali metal preferably KI or KI_3. (NPO) (UK)

35296 METHOD FOR REPROCESSING URANIUM-CONTAINING NUCLEAR FUELS. (to Kernforschungsanlage Juelich des Landes Nordhein-Westfalen eV). French Patent 1,455,571. Filed Nov. 18, 1965.

A method for the reprocessing of a U-containing nuclear fuel comprises fluorinating the fuel or a mixture of the fuel and an inert substance, e.g., corundum or fluorspar, at a temperature in the range from 800 to 900°C with SF_6 either alone or mixed with an oxidizing agent. The fluorination is preferably carried out in a fluidized bed in two steps: (1) heating up the starting materials to a temperature in the range 700 to 900°C in order to volatilize the low-boiling fission product fluorides and, (2) raising the temperature in the range from 850 to 900°C for forming UF_6 from the UO_2F_2 formed in the first heating. If fuels in the form of coated particles are to be reprocessed, the particles are preferably mechanically comminuted prior to the fluorination or treated with O_2 or a mixture of SF_6 and O_2 in the presence of combustion catalysts if necessary at a temperature in the range from 900 to 1100°C. (NPO)

35297 METHOD FOR THE EXTRACTION OF MATERIALS EMBEDDED IN A GRAPHITE BODY. (to Oesterreichische Studiengesellschaft fuer Atomenergie GmbH). French Patent 1,502,691. Filed June 30, 1966.

A method for the extraction of materials embedded in a graphite body comprises heating the body to a temperature below 325°C and subjecting it to the action of the vapor of one or more elementary halogens or interhalogen compounds until the body disintegrates and the embedded particles can be removed. If the embedded particles are surrounded with coating layers either the graphite body shortly before its destruction or the loose particles after destruction are subjected to thermal shock by being heated rapidly to a temperature in the range from 2500 to 3000°C so that the coatings burst. After disintegration of the body the loose particles are treated with either elementary Cl_2 or an inert gas saturated with CCl_4 to form volatile chlorides with the materials of the particles. The addition of a small amount of S_2Cl_2 to facilitate the formation of the volatile chlorides is advisable. (NPO)

35298 METALS PROCESSING: NEW METHODS MAY KEEP MILLS EFFICIENT. Can. Chem. Process., 53: 85-7 (June 1969).

Techniques for U processing in Canadian mills built in the 1950's are reviewed. A proposed new method indicates that air-oxidation pressure leaching could improve the rate of extraction as compared with atmospheric pressure leaching. Details are described briefly and a comparison made with solvent extraction and ion exchange methods. (F.S.A.)

35299 ENRICHMENT OF STABLE ISOTOPES. III. ENRICHMENT OF ^6Li AND ^7Li BY ION EXCHANGE COLUMN. Hagiwara, Zenzi; Takakura, Yoshihisa (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo), 6: 326-32(June 1969).

In search of a suitable ion exchange method for the enrichment of Li isotopes, column elutions of the Li band were examined under various conditions. For long distance displacement of the Li band, barium acetate and calcium acetate were excellent as eluant, and the Li proved to be very well retained by the hydrogen bed with Dowex 50 W-X 12, 50 to 100 mesh. From the standpoint of resin utilization and regenerant efficiency in cyclic column operation, calcium acetate was preferable to barium acetate. Enrichment experiments were carried out with Li isotopes, using the above exchange systems, which proved that ^7Li and ^6Li were well concentrated in the respective ends of the Li adsorption band. In one run, the ^7Li and ^6Li were enriched to 97.09 and 14.64% respectively in the front and rear edges of the band. (auth)

35300 APPARATUS FOR THE CHEMICAL TREATMENT OF SOLIDS. (to Centre d'Etude de l'Energie Nucleaire). French Patent 1,496,449. Filed Oct. 12, 1966.

An apparatus is described for the chemical treatment of solids, specifically for the chlorination of spent nuclear fuels. The apparatus is made up of an inclined tubular vessel in which the chlorination is effected, an inlet in the mid-portion of the vessel for introduction of the solid, a chamber connected with the upper end of the vessel to collect the volatile reaction products, and a chamber connected with the lower end of the vessel to collect the solid reaction products and provided with an inlet to introduce a gaseous treatment agent. (NPO)

35301 METHOD OF EXTRACTING METAL COMPOUNDS FROM ORGANIC SOLUTIONS. (to Aktiebolaget Atomenergi). French Patent 1,445,834. Filed Aug. 6, 1965.

A chromatographic method is described for extracting metal compounds from organic solutions obtained in regeneration of irradiated nuclear fuels, e.g., compounds of Pu, Np, U, Th, Mo, and Tc. The method comprises feeding the organic solution into a column of a fine-grained solid material, e.g., silica-gel, infusorial earth, or bentonite, having absorbed on its particles an aqueous solution of a compound that reacts with the metal compound to be extracted to transform the latter into a compound, which is insoluble in the organic solution and which is retained in the column; eliminating the organic solution; and eluting the retained metal compound by means of a suitable agent. If the metal compound to be extracted is a Pu compound the aqueous solution contains a sulfate, preferably $(NH_4)_2SO_4$, and the Pu is eluted by diluted nitric acid. In a modification the aqueous solution consists of a saturated solution of oxalic acid and the Pu is eluted by concentrated nitric acid. If the metal compound to be extracted is a Mo compound the aqueous solution is nitric acid having a concentration of 6 to 14 N and the Mo is eluted by means of a NaOH solution having a concentration of 1 to 5 N. (NPO)

35302 METHOD OF EXTRACTING FISSILE MATERIAL FROM ORGANIC SOLUTIONS. (to Saint-Gobain Techniques Nouvelles). French Patent 1,502,752. Filed Aug. 8, 1966.

A method of extracting residual fissile materials from organic solutions obtained in a regeneration process of irradiated nuclear fuel, e.g., a solution of TBP in dodecane containing slight quantities of U and dibutyl phosphate consists of treating the organic solution with an aqueous salt solution, preferably a solution of Na_2CO_3 having a concentration of about 0.25 M. The U and the dibutyl phosphate pass into the aqueous solution, which after acidification to at least 1 N is extracted with aromatic hydrocarbon, e.g., benzene, toluene, xylene, or a mixture of hydrocarbons, with the dibutyl phosphate being transferred to the organic phase and the U being retained in the aqueous phase. (NPO)

35303 PROCESS FOR SEPARATING URANIUM FROM NUCLEAR FISSION PRODUCTS. (to Japan Atomic Energy Research Inst.). French Patent 1,472,438. Filed Mar. 17, 1966.

A process for separating U from nuclear fission products includes treating the U values at a temperature in the range from 450 to 700°C with a chlorinating agent, e.g., CCl_4, phosgene, hexachlorethane, tetrachlorethylene, or hexachloro-1,3-butadiene; absorbing the formed volatile chlorides at a temperature in the range from 150 to 500°C on a bed of $BaCl_2$; desorbing the chlorides of the fission products from the bed by passing a stream of CCl_4 vapor diluted with Ar, N_2, or H_2 through the bed at a temperature below 583°C; desorbing the UCl_4 from the bed and converting it into UCl_6 by passing a stream of Cl_2 or a Cl_2-containing gas through the bed at a temperature in the range 400 to 700°C; and collecting the vaporized UCl_6. The Cl_2-containing gas for desorbing the UCl_4 preferably consists of Cl_2 diluted with CCl_4, Ar, or N_2. (NPO)

35304 PROCESS FOR REPROCESSING USED URANIUM FUEL. (to Japan Atomic Energy Research Inst.). French Patent 1,446,640. Filed Sept. 8, 1965.

Used nuclear fuel consisting of metallic U, U carbide, UO_2, UO_2–graphite or U_3O_8 was dissolved in a molten salt bath consisting of NH_4NO_3 and one or more nitrates of alkali metals with or without one or more chlorides of alkali metals at a temperature >210°C. After the molten salt was filtered through a glass or quartz fiber filter, glass powder, γ-Al_2O_3, or Ca oxalate packed in a column, the filtrate was heated to at least 330°C in order to expel gaseous fission products, thereby obtaining U as a U compound precipitate. Preferably the mixed salt bath contains at least 5 times as much NH_4NO_3 as the amount of U to be treated. If the glass powder of γ-Al_2O_3 has selectively retained Zr and Nb, a radiologically pure Zr–Nb may be obtained by treating the glass-powder or the γ-Al_2O_3 with a molten salt mixture comprising 50 wt % KNO_3 and 50 wt % $LiNO_3$ and containing oxalic acid in an amount of at least 1 wt % to convert the Zr–Nb to the oxalate, and then separating the glass-powder or the γ-Al_2O_3 from the molten salt by filtration with a sintered glass or quartz filter. (NPO)

35305 PROCESS FOR THE SEPARATION OF A MIXTURE OF METAL FLUORIDES CONTAINING URANIUM HEXAFLUORIDE. (to United Kingdom Atomic Energy Authority). French Patent 1,450,004. Filed Sept. 30, 1965.

A process for separation of a mixture of metal fluorides containing UF_6 comprises contacting the fluoride mixture with liquid anhydrous HF by vaporizing the mixture of fluorides and passing the vapor through the liquid, and then recovering the UF_6 by distillation or crystallization. In a modification the U is recovered in the form of oxyfluoride by adding water to the HF solution. (NPO)

35306 PROCESS FOR FLUORINATING IRRADIATED NUCLEAR FUELS. (to Centre d'Etude de l'Energie Nucleaire). French Patent 1,483,284. Filed June 14, 1966.

Irradiated nuclear fuels containing at least one nuclear metal oxide and fission products are reprocessed by subjecting the fuel to the action of gaseous ClF_3 at a temperature below 500°C, preferably between 25 and 300°C. If the fuel contains a mixture of U oxide, Pu oxide, and fission products, the process is effected in two steps: treating the fuel with ClF_3 at a temperature below 200°C to convert the U oxide into volatile UF_6 and raising the temperature to about 500°C and continuing the fluorination to convert the Pu oxide into volatile PuF_6 while the fission products remain in the solid state. (NPO)

35307 METHOD FOR SEPARATING URANIUM FROM REFRACTORY AND NOBLE METALS. (to United States Atomic Energy Commission). French Patent Filed Aug. 30, 1966.

A method is described for separating U from refractory and noble metals that forms part of a process for the regeneration of spent nuclear fuels from which the Pu values were extracted previously. The materials to be separated are introduced into a molten Cu–Mg alloy containing 4 to 8 wt % Mg and the alloy is contacted with a molten chloride, preferably $MgCl_2$. The U is converted into its chloride, which dissolves in the molten salt, and then the molten salt mixture is contacted with a molten Mg–Zn alloy containing 30 to 65 wt % Zn, which reduces the uranium chloride to metallic U that precipitates out of the alloy. The process is carried out in an inert atmosphere at a temperature in the range 725 to 850°C. Alternately, the Cu–Mg alloy and the Mg–Zn alloy are simultaneously contacted with the molten salt, the latter forming a supernatant layer on both alloys, which are disposed in a vessel provided with a partition that separates the alloys from one another. (NPO)

35308 DECANNING MACHINE FOR NUCLEAR FUEL ELEMENTS. (to Commissariat a l'Energie Atomique). French Patent 1,411,744. Filed July 10, 1964.

A machine for decanning fuel elements consisting of a cylindrical fuel rod provided with an outer can comprises an even number of cutting wheels carried by a frame and regularly distributed so as to form grooves along equidistant generatrices in the can on advancement of the can axially through the frame. One of the cutting wheels is provided with a separating wedge adapted to engage beneath the can portions as the can advances and cause the portions to pivot about the grooves formed by the two adjacent cutting wheels not provided with separating wedges. Each cutting wheel may be provided with a regulating system to adapt the machine to the decanning of rods of various diameter. Preferably two coaxial tubes are provided for collecting separately the rod and the can portions separated from the rod. (NPO)

35309 DECANNING MACHINE FOR NUCLEAR FUEL OR FERTILE ELEMENTS. (to Gesellschaft fuer Kernforschung mbH). French Patent 1,496,276. Filed Oct. 7, 1966.

A machine is described for decanning rod-type fuel or fertile elements in which the element is advanced by transport rollers for the axial feed and cutting tools are provided for the execution of longitudinal cuts in the element can. The machine is provided with a hollow drill rotatable around the longitudinal axis of the element to be decanned and having an outside diameter equal to the inside diameter of the can. The drill is surrounded with a slight radial clearance by a hollow stationary cutting tool with the drill and cutting tool being supported by a housing, which is provided with several channels having a segmental cross-section to discharge the canning segments expanded by the cutting tool. (NPO)

35310 EXTRACTION OF ^{241}Am FROM CONCENTRATED AQUEOUS CHLORIDE SOLUTIONS BY TRILAURYLAMINE HYDROCHLORIDE. Jain, H. C.; Duyckaerts, G. (Univ. of Liege). Inorg. Nucl. Chem. Lett., 5: 553-9(July 1969).

Several hypotheses have been advanced with regard to the mechanism of extraction and to the stoichiometry of the extracted complexes in metal–trilaurylamine salt systems. The difficulty of obtaining information from metal distribution curves against amine salt concentration in the organic phase arises from the fact that the amine salt is aggregated to a degree depending on its concentration and the nature of the diluent. In order to obtain more information about the validity of the distribution method from the point of view of determining the nature of the extracted species, determinations were made of the distribution of ^{241}Am between aqueous LiCl, $CaCl_2$, dilute HCl solutions and solutions of trilaurylamine hydrochloride in different diluents at tracer metal concentrations and under metal loading conditions. The distribution experiments were conducted at an amine concentration range as large as possible, in order to vary the degree of aggregation in the organic phase. (auth) (UK)

35311 RAPID CHROMATOGRAPHIC ELUTION OF A TRACER LANTHANIDE USING HIGH PRESSURE ION EXCHANGE. Campbell, D. O.; Ketelle, B. H. (Oak Ridge National Lab., Tenn.). Inorg. Nucl. Chem. Lett., 5: 533-7(July 1969).

Very rapid chromatographic elutions of trace concentrations of a rare earth element [Pr(III)] in a small pressurized ion exchange column are described. Elutions of praseodymium tracer were carried out at such flow rates that the rare earth was eluted in times as short as one minute for the number of column volumes of solution normally required to obtain good chromatographic separation of adjacent lanthanides. Although all elution bands show "tailing" at low concentrations on the back edge, bands obtained at higher flow rates are broadened considerably. (auth) (UK)

35312 SOLVENT EXTRACTION OF SOME METALS BY MIXTURES OF TRIBUTYL PHOSPHATE WITH ALKYLAMMONIUM NITRATES. Kolarik, Z.; Puzic, R. G.; Maksimovic, Z. B. (Boris Kidric Inst. of Nuclear Science, Belgrade). J. Inorg. Nucl. Chem., 31: 2485-98(Aug. 1969).

The distribution of cerium(III), zirconium(IV), and plutonium(IV) was studied in systems where 3M nitric acid was the aqueous phase and a solution of tributyl phosphate and trilaurylammonium or trilaurylmethylammonium nitrates in n-hexane or toluene was the organic phase. A synergic effect was observed in the extraction of cerium(III) and zirconium(IV); it was explained by the formation of mixed metal nitrate–tributyl phosphate–alkylammonium nitrate complexes. No significant mixed complex formation is assumed in the extraction of plutonium(IV), where an antagonistic effect was observed in most cases. The effect was ascribed to the lowering of the activity coefficients of the alkylammonium nitrate extracting species in the presence of tributyl phosphate. (auth) (UK)

35313 METHOD OF EXTRACTING CESIUM VALUES FROM AN AQUEOUS SOLUTION OF FISSION PRODUCTS. (to Societe Saint-Gobain Techniques Nouvelles). French Patent 1,480,148. Filed Jan. 12, 1966.

Cesium values were extracted from an aqueous solution of fission products by passing the solution through a column consisting of a support material, e.g., an anion exchange resin or fiber glass, charged with a mixed ferrocyanide of an alkali metal, e.g., $[Fe(CN)_6]NiNa_2$ or $[Fe(CN)_6]CuK_2$, with the Cs being captured in the form of $[Fe(CN)_6]MCs_2$. (NPO)

35314 METHOD OF EXTRACTING PLUTONIUM FROM ORGANIC SOLUTIONS. (to Gesellschaft fuer Kernforschung mbH). French Patent 1,496,277. Filed Oct. 7, 1966.

Plutonium was extracted from solutions of Pu(IV) in an organic solvent, e.g., TBP by treating the solutions in a countercurrent process with a slightly acidified aqueous solution of a nitrite, preferably $NaNO_2$, acidified with HNO_3 to a concentration not exceeding 0.3 N. By this process the Pu(IV) is immediately reduced to Pu(III) and almost completely transferred to the aqueous solution. (NPO)

35315 PROCESS FOR THE PURIFICATION OF URANIUM OXIDE NUCLEAR FUEL. (to EURATOM). French Patent 1,412,985. Filed Nov. 3, 1964.

A process is described for the purification of UO_2 nuclear fuel in which the UO_2 is halogenated and suspended in a melt consisting of molten alkali metal halides. The UO_2 is precipitated from this melt by reduction of the halogenation product. The precipitation is effected by reduction of the halogenated product in two or more steps and the fractions precipitated by the successive steps are separated from one another. Preferably a first precipitation is effected to precipitate about 1% of the U present and a second precipitation is effected to precipitate about 98% of the U present. The reduction may be effected by a mixture of H_2 and a noble gas. (NPO)

35316 METHOD OF EXTRACTING STRONTIUM VALUES FROM AN AQUEOUS NITRIC ACID SOLUTION. (to Commissariat a l'Energie Atomique). French Patent 1,485,541. Filed Jan. 5, 1966.

A method of extracting Sr values from an aqueous HNO_3 solution resulting from the processing of irradiated nuclear fuel materials comprises feeding the solution through an ion exchange column consisting of antimonic acid and eluting the retained Sr with 0.1 to 0.5 M $AgNO_3$ containing HNO_3 in the range from 1 to 2 N. After elution, the ion exchanger is regenerated by washing with

3 to 6 N HNO_3 or a solution of K thiocyanate. Preferably the elution is effected at a temperature of 60°C. (NPO)

35317 METHOD FOR FLUORINATING NUCLEAR FUELS. (to Centre d'Etude de l'Energie Nucleaire). French Patent 1,501,370. Filed Nov. 21, 1966.

A method for fluorination of nuclear fuels is described in which the fuel is subjected to the action of a gaseous mixture of elementary F_2 and an interhalogen compound containing F, e.g., ClF_3, at a temperature between the boiling point of the compound and 500°C. (NPO)

35318 PROCESS FOR THE REGENERATION OF IRRADIATED CERAMIC NUCLEAR FUELS. (to EURATOM). French Patent 1,448,868. Filed June 9, 1965.

A process for the regeneration of irradiated ceramic UO_2- or UC-containing nuclear fuels includes the introduction of the fuel or the comminuted fuel element into molten NaOH at a temperature in the range from 350 to 450°C in the presence of an oxidizing agent, e.g., air or Na_2O_2, with the U values being converted into Na_2UO_4, which is insoluble in the melt, and the disintegration gases, e.g., Kr and Xe, being separated from the melt by evacuation; elimination of the undissolved parts of the sheath of the element, if present, by means of a sieve having relatively wide meshes; separation of the insoluble Na_2UO_4 from the melt by means of a centrifuge or a porous graphite filter; precipitation of the dissolved fission products and matrix materials from the melt in the form of a solid waste product by adding Al_2O_3 and/or SiO_2 or other suitable adsorbing oxides to the melt; introduction of the Na_2UO_4 into a molten halide or sulfate, preferably a halide or sulfate of Al or a bisulfate or a pyrosulfate of an alkali metal or ammonia, to convert the uranate into the corresponding uranyl salt; and passage of NH_3 and/or H_2 through the melt to reduce the uranyl salt to UO_2, which precipitates out of the melt. (NPO)

35319 PROCESS FOR DIRECT SEPARATION AND RECOVERY OF PLUTONIUM FROM IRRADIATED NUCLEAR FUEL. (to Japan Atomic Energy Research Inst.). French Patent 1,404,876. Filed Aug. 10, 1964.

A process for the direct separation and recovery of Pu from irradiated nuclear fuel comprises pulverizing the irradiated fuel by repeated oxidation and reduction by means of O_2 and H_2, mixing the pulverized fuel in the oxidized state with a high-molecular-weight alkyl tertiaryamine nitrate, e.g., trioctyl-, trilauryl-, or cyclohexyldilaurylamine nitrate, preferably diluted with kerosene containing up to 10 vol % of octylalcohol, separating the resultant Pu-amine complex from the residue and then precipitating the Pu as the oxalate with an oxalic acid solution. (NPO)

35320 METHOD OF EXTRACTING RUTHENIUM FROM BASIC SUSPENSIONS. (to Commissariat a l'Energie Atomique). French Patent 1,515,048. Filed Nov. 3, 1966.

A method is described for extracting Ru from a basic suspension obtained by subjecting an irradiated Pu–Al alloy to selective dissolution by 6N NaOH. The suspension is composed of a solution containing the Al and a precipitate containing the Pu and Ru as the principal fission products. The suspension as a whole or the precipitate alone is treated with an oxidizing agent, preferably a basic solution of NaOCl in such a quantity that the end concentration of the NaOCl is about 0.01 to 0.1M and that of the OH ions is about 0.5N. This oxidizes the hexavalent Ru to heptavalent Ru, which is simultaneously dissolved. The solution thus obtained is separated from the precipitate containing the Pu and is then extracted with a solution of a salt of a quaternary amine, preferably trilaurylmethylamine chloride having a concentration of 0.05M in an organic solvent, e.g., xylene or CCl_4. Finally the Ru is precipitated out of the organic solution by adding an aqueous solution of 0.1N NaOH containing 10 vol% of ethanol. (NPO)

35321 METHOD OF EXTRACTING PLUTONIUM FROM AQUEOUS SOLUTIONS. (to Commissariat a l'Energie Atomique). French Patent 1,455,188. Filed June 29, 1965.

Plutonium can be extracted from aqueous solutions containing U, Pu, and fission products by countercurrent treatment of the solutions with an organic solvent, e.g., TBP, in a series of vessels each provided with a mixing and decanting apparatus and with an electronic detector responding to the quantity of Pu retained in the vessel. The flow ratio of the aqueous solution and the organic solvent is regulated by a differential mechanism, which is automatically controlled by the signals obtained from the detectors. The electronic equipment is described in detail. (NPO)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 35404, 35433, 35490, 35492, 35502, 35505, 35511, 35512, 35534–35536, 35538, and 35539.

35322 (IAE-1519) DETERMINATION OF THE CONCENTRATION AND SPATIAL DISTRIBUTION OF THORIUM IN MINERALS AND ROCKS ACCORDING TO THE TRACES FROM FISSION FRAGMENTS. Berzina, I. G.; Gurvich, M. Yu.; Khlebnikov, G. I. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1968. 8p. (In Russian). Dep.

Descriptions are given of a high-sensitivity method for determining the concentration and spatial distribution of thorium in minerals and rocks. A detector was used for recording (n-f) reactions on thermal and fast neutron tracks produced by thorium fission fragments. Uranium and thorium targets with ^{235}U, ^{238}U, and ^{232}Th were used in the experiment. In specially prepared specimens with thorium–uranium ratio of 1:3 and over and neutron flux 10^{16} n/cm^2 the method sensitivity is equal to 10^{-9} g/g. (R.V.J.)

35323 IMPROVEMENT IN A PROCESS FOR INJECTING RADIOACTIVE RESIDUES INTO THE SOIL. (to Commissariat a l'Energie Atomique). French Patent 1,438,454. Filed Mar. 30, 1965.

A process is described for disposal of radioactive residues by mixing the residues with cement to form a liquid or slurry and injecting the mixture into the soil. An aldehyde or a substituted phenol is added to the mixture to form, preferably after hardening of the cement, a cold-setting resin, which fixes the decantation water of the mixture. The preferred cement is one such as aluminous cement having a low Ca content. The aldehyde and phenol are added in a proportion by weight ranging from 0.3 to 3.0. (NPO)

35324 OKHRANA PODZEMNYKH VOD OT RADIOAKTIVNYKH ZAGRYAZNENII. (Protection of Ground Waters from Radioactive Contamination). Belitskii, A. S.; Orlova, E. I. Moscow, Izdatel'stvo Meditsina, 1968. 208p.

The protection of ground waters from radioactive contamination is discussed. Possible methods of radioactive contamination of water-bearing formations and the principal factors which determine the movement of radioactive materials in ground waters are considered. Undesirable consequences caused by the contamination of ground waters can be eliminated if the necessary conditions are observed in the disposal of radioactive wastes. It is necessary to take these conditions into account in order to estimate the migration of radioactive materials in ground waters. Published data on hydrodynamic concepts, chromatographic studies, and data obtained by the authors provide methods for the preliminary determination and evaluation of the migration of radioactive materials in contaminated ground waters. However, the requirements for the protection of ground waters from radioactive contamination cannot be based on the results of approximate calculations. More precise data are presented for the estimation of ground water contamination. The work was done to assist sanitation specialists, hydrogeologists, engineers, and various other specialists working in the field of ground water protection. An extensive bibliography is included. (tr-auth)

35325 THE USE OF ^{222}Rn IN SURFACE WATERS IN GEOCHEMICAL PROSPECTING FOR URANIUM. Dyck, Willy; Smith, A. Y. (Geological Survey of Canada, Ottawa). Quart. Colo. Sch. Mines, 64: 223-36(Jan. 1969).

In a geochemical U prospecting study, a feasibility test of the use of ^{222}Rn in surface waters was carried out. Radon-222 and U contents in 150 water samples from 140 sample sites in the Bancroft, Ontario, and Ottawa-Hull districts were found to vary from 0 to 2200 pCi/l and 0 to 47 ppB, respectively. A difference was observed between the Rn content of lakes and ponds (0 to 262 pCi/l, with some of the higher values being near U mining operations) and that of creeks and streams (0 to 2200 pCi/l). No such variation was noted for U. Although the correlation between Rn and U values in the waters was marginal, the results indicated a gross areal correlation between Rn or U content of surface waters and uraniferous areas. Spot measurements in winter showed that Rn levels in lake waters under the ice increased as expected but remained more or less constant in creeks. Uranium levels, on the other hand, remained more or less constant in lakes but decreased noticeably in creeks. The low cost and simplicity of the Rn method suggest its use as a preliminary reconnaissance geochemical prospecting method. (BBB)

35326 MEASUREMENT OF ISOTOPIC DISTRIBUTION IN THE EVALUATION OF OIL FIELDS. Blaga, L. (Institut de Physique Atomique, Cluj). pp 415-32 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969. (In French).

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The isotopic concentrations in newly opened hydrocarbon deposits show certain regularities of distribution. The existing isotopic distributions in the fluids present in natural porous media are the cumulative result of certain steady-state processes of physical, chemical, and other types which take place in layers of rock. These distributions are reflected in the isotopic distribution obtaining between the various components of the fluids in oil-bearing formations and the gradients of isotopic concentrations appearing over extended distances. The isotopic distribution existing between the different components of the fluids in oil-bearing deposits is the result of isotopic equilibrium or of a process tending towards such equilibrium. Agreement can be obtained between the calculated values and those obtained, for example, in the methane-deposit water system. The isotopic concentration gradients, recorded over considerable distances within one phase, are primarily the result of a geothermal gradient. Two characteristic phases are noteworthy from the point of view of the distribution of isotopic concentration gradients in hydrocarbon deposits: the starting phase of isotopic distribution, pre-existing in the deposit, which is a result of the temperature gradients. This distribution can be incorporated in a system of isotopic isoconcentrates (lines of equal isotopic concentration), which can be correlated with the structure of the deposit and also with the various physical, chemical, and mechanical factors characteristic of porous media, and the secondary phase of isotopic distribution, corresponding to the period of operation. The extrapolation process results in imbalances due to pressure and water flooding and in large-scale movements of oil from one zone to another. If one considers the isotopic distribution of the starting phase as an initial, natural isotopic labeling, it would appear possible to follow the changes in initial distribution as the exploration operations go on. Knowledge of the isotopic distribution and the laws to which it is subject can thus serve as a source of information for a large number of useful parameters in operations connected with the detection of deposits and with their exploitation. (auth)

35327 ADVANCES IN NUCLEAR GEOPHYSICAL METHODS IN OIL GEOLOGY AND ROCK ANALYSIS. Caldwell, R. L.; Mills, W. R.; Givens, W. W. (Mobil Research and Development Corp., Dallas). Contract NASw-1435. pp 397-413 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Nuclear techniques have been developed for the analysis of rocks in the laboratory and in the earth surrounding boreholes drilled to search for oil and other useful minerals. A combination of neutron methods offers the possibility of giving analysis for most of the common elements found in igneous and sedimentary rocks. A summary is presented of two-year extensive study of the combination neutron method for analysing surface rocks of the moon and planets. The combination method uses a pulsed accelerator source of 14-MeV neutrons and measurement of prompt gamma-rays, capture gamma-rays, activation gamma-rays, and thermal and epithermal neutron die-away. From this work has come the new technique of cyclic neutron activation, which is applicable to lunar surface analysis, borehole logging and on-stream analysis of rocks and minerals. Rock analysis studies have been made with a high resolution lithium-drifted germanium detector and a pulsed accelerator source of neutrons. The detector resolution of 0.5% at 1.3 MeV is about an order of magnitude better than for a good sodium iodide detector. Gamma-rays arising from inelastic scattering of fast neutrons, capture of fast and slow neutrons, and activation were studied. From the results with the high resolution detector some interesting conclusions and speculations are made concerning the future of nuclear elemental analysis in the field. The present activity in the United States of America in commercial nuclear logging is summarized including neutron logging (steady-state and pulsed methods), scattered gamma-ray logging, and combinations of logs for identifying lithology and non-metallic minerals. A new small-diameter pulsed accelerator

neutron tool for logging through 2½-in. tubing is described, and a pulsed neutron source using a plurality of alpha sources and beryllium targets with a rotatable shutter between them is discussed. (auth)

35328 NEUTRON METHODS IN GEOPHYSICS. Czubek, J. A. (Inst. of Nuclear Research, Krakow). pp 3-21 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The applications of neutron methods in geophysics are compared with other nuclear methods in the light of recent progress. These methods are applied to the analysis of geophysical examples in field prospecting, borehole logging and in the laboratory. The elements detected by nuclear geophysics methods are listed. Such detection is possible using the 12 principal neutron methods. The present trend is concentrated on quantitative information concerning the geological formations under investigation which can be treated by these methods. This claim can be fulfilled if the theory of each method is elaborated for the different rock and ore media, but this is not easy even for the simplest case. Problems discussed are: the slowing-down length of fast neutrons in rock media; thermal neutron diffusion parameters for rocks; the influence of rock heterogeneity on the response of neutron methods; and comparisons between theory and experiment for the neutron-neutron method. The two main fields of application of the neutron methods are in oil geophysics and ore geophysics. Recent developments in these fields are outlined and some remarks are made on neutron soil moisture measurements (calibration curve, range, etc.). (auth)

35329 RATIO OF ^{90}Sr AND CALCIUM IN CERTAIN MINERAL AND PEAT-SWAMPY SOILS. Ivanov, S. N.; Shagalova, E. D. Dokl. Akad. Nauk BSSR, 13: 269-71(Mar. 1969). (In Russian).

The uptake of strontium-90 by plants is not only dependent on the ^{90}Sr in soils, but also the Ca content. The ratio of ^{90}Sr and calcium is expressed in strontium units (CE). Even though there is a higher strontium-90 content in peat soils than in mineral soils, the uptake of strontium-90 is lesser in the peat soils. There is a higher CE index in sandy soils than in loam or turf soils. (tr-auth)

35330 USE OF TRITIUM AS AN INDICATOR FOR SUBTERRANEAN WATERS. Abdullaev, A. A.; Khaitov, B. K.; Zakhidov, A. S.; Anischenko, I. M. Z. Angew. Geol., 14: 86-8(1968). (In German).

The theory and procedures for measurement of subterranean ground waters by means of ^{3}H and ^{131}I are described. The equipment used is briefly described. In contrast to other ions, the movement of ^{3}H was subject to laws of diffusion in flow and to factors such as initial volume of indicator, dilution coefficient, observation time, and the spatial coordinates of the ^{3}H. Mathematical relations were presented for the initial activity of the ^{3}H, the physical characteristics, relative locations of the test probes, and methods for calculation of soil porosity, and velocity of ^{3}H tracer movement. (BBB)

35331 ENERGY DISTRIBUTION OF SCATTERED GAMMA-RAYS IN NATURAL GAMMA-LOGGING. Czubek, J. A. (Inst. of Nuclear Research, Krakow); Lenda, A. pp 105-16 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Natural gamma-logging is one of the most fundamental and most widely used methods in nuclear geophysics. It is most helpful for the lithological estimation and for evaluating the concentration of radioactive elements in rocks. One of the problems connected with this method which still remains unsolved is the question of the units in which the results of the measurements should be expressed. The main interest in such measurements is always the concentration of radioactive material, q, and as a result of the measurements one obtains the gamma-radiation intensity I, which is determined not only by the concentration q, but is also strongly influenced by factors such as the type of detector, the geometrical and absorptive characteristics of the borehole and the chemical composition of the rock, which causes a variation of the photoelectric absorption coefficient μ_{ph} with the equivalent atomic number of the medium Z_{eq}. Details are given of the first steps in the long-term research being carried out in the Institute of Nuclear Techniques and in Department 6 of the Institute of Nuclear Research in Cracow. This research, which will cover both theory and experiment, aims to find the proper conditions for an equivocal relationship between measured intensity I and concentration q, which for Clark's abundances of the radioactive elements in rocks is one of the factors determining its lithological origin. (auth)

35332 MIGRATION OF URANIUM IN RIVERS AND THE DURATION OF ITS PRESENCE IN WATERS OF THE WORLDS OCEANS, SEAS, AND LAKES. Baturin, G. N.; Kochenov, A. V. (Inst. of Oceanology, Moscow). Geokhimiya, No. 6, 715-23(June 1969). (In Russian).

The average uranium content in the total amount of dissolved and suspended materials of river run-off is similar to its average content in rocks of the Earth's crust. The rivers of the Earth every year supply the World ocean with approximately 20,000 tons of dissolved uranium and with approximately as much suspended uranium at a ratio of 1:1. In final run-off basins the prevailing part of dissolved uranium is precipitated together with terrigenous material on shelfs and continental slopes. The time of dissolved uranium stay in waters of the basins varies from tens of years to hundreds of thousands years and depends on their depth. (auth)

35333 DECAY PRODUCTS OF U AND Th IN ACTIVE VOLCANISM OF USSR. Kuptsov, V. M.; Cherdyntsev, V. V. (Geological Inst., Moscow). Geokhimiya, No. 6, 643-58(June 1969). (In Russian).

Contents and ratios of isotopes: ^{238}U, ^{234}U, ^{232}Th, Io, RdTh (^{228}Th), ^{227}Ac, ^{226}Ra, MsTh, ^{228}Ra, ^{210}Pb were investigated in 70 specimens of waters (vapor condensates and fumarole waters) and fumarole minerals of the same volcanoes from the Kamchatka and Kuril Islands. The first determinations of radioactivity of vapor condensates are given. The contents of the isotopes decrease consequently: $^{234}U > ^{238}U >$ Io $> ^{232}Th > ^{231}Pa$ (the primordial and longlived isotopes) and: Rn > MsTh > ^{226}Pa > Pb(?) > ^{227}Ac (the isotopes collected as recoil atoms). The values of isotope contents and their ratios varied in wide ranges, but the average values are rather constant. (auth)

35334 ^{239}Pu IN NATURE. Cherdyntsev, V. V.; Zverev, V. L.; Kuptsov, V. M.; Kislitsina, G. I. (Geological Inst., Moscow). Geochem. Int. (Engl. Transl.), 5: 355-61(1968).

Translated from Geokhimiya, No. 4, 395-401(1968).

The content of ^{239}Pu, the α-decay (4.4 to 4.6 MeV) product of an unknown transuranium isotope, was determined in various natural materials. The geochemical features of Pu and the chemical behavior of the unknown isotope are discussed. (auth)

35335 ESTIMATION OF AGE OF URANIUM-BEARING HYDROMORPHOUS SOILS ON THE BASIS OF IONIUM ACCUMULATION. Andreev, A. G.; Komarov, V. S.; Lopatkina, A. P.; Sergeev, A. N. Geokhimiya, No. 6, 724-8(June 1969). (In Russian).

Conditions for making age determinations on the basis of ionium accumulation for the case of hydromorphous soils with high uranium content were considered. Equilibrium between the solid and liquid phases in places of contact of feeding uranium-bearing waters with organic material is comparatively rapidly set within several years. The concentration of ionium carried into hydromorphous soils together with uranium, may be negligible and not be taken into account when estimating the age. The age of thin bog soils with high uranium content, which was estimated in three regions of Eastern Siberia, varied in the ranges of 1600 to 2800 years. The age of buried soil with a 40 to 50 cm depth has been estimated as being 4800 years. (auth)

Meteorology

Refer also to abstract 35540.

35336 RADIOSTRONTIUM IN THE AIR AND SURFACE DEPOSITION. Lalit, B. Y.; Chandrasekaran, V. R. (Bhabha Atomic Research Centre, Bombay). J. Sci. Ind. Res., 27: 335-8(1968).

The results of measurements of radiostrontium in the air and its surface deposition at Bombay for the period 1956 to 1965 are described. The rate of ^{90}Sr deposition was lowest in 1957 and highest in 1963. The rate of ^{90}Sr fallout decreased in 1964 and dropped further in 1965 to almost the 1959 rate. The rates of ^{90}Sr fallout during the test moratorium period from 1959 to 1961 also showed decreasing trends. Most of the deposition of ^{90}Sr takes place in the rainy season in Bombay. The fact that no ^{90}Sr had been injected into the stratosphere after October 1958 till September 1961 could be used as a basis to calculate the stratospheric residence time of ^{90}Sr. French atomic explosions of February and April 1960 contributed no more than 0.1 to 0.2% of the total ^{90}Sr in the stratosphere and could be neglected in the calculations. The value of residence time for the 1963 to 1965 period is ~1 yr. A plot of $^{89}Sr/^{90}Sr$ ratio in surface deposition against time in days, and levels of ^{90}Sr activity in ground level

air are given. The peak in $^{89}Sr/^{90}Sr$ ratio in June 1962 in ground level air corresponded to the U. S. Pacific tests of 1962. This was supported by the shift of the points of activity ratio for July 1962 and August 1962 to the right-hand side of the decay line for the first half of 1962. From September 1962 onwards, the $^{89}Sr/^{90}Sr$ ratio increased rapidly till the end of tests in December 1962, due to continuous influx of fresh activity from 1962 USSR test series. This rise reached a maximum value in January 1963 for surface fallout and in December 1962 for air filter samples. The calculated deposition velocities of ^{89}Sr and ^{90}Sr are presented. The deposition velocity of ^{90}Sr was, in general, more than that of ^{89}Sr during the period of fallout of recent origin (i.e., from November 1961 to February 1963). (BBB)

35337 SAMOOCHISHCHENIE ATMOSFERY OT RADIOAKTIVNYKH ZAGRYAZNENII. (Atmospheric Self-Purification from Radioactive Contamination). Styro, B. I. Leningrad, Gidrometeorologicheskoe Izdatel'stvo, 1968. 288p.

Experimental methods for the definition of the balance components of radioactive products in the atmosphere are presented in this monograph. The radioactive contamination processes in the atmosphere are considered. The problems of radioactive decay products in the atmosphere, their deposition with atmospheric dust, their washout by clouds and precipitation, and the possibility of radioactive products removal from the atmosphere are discussed. The information is based mainly upon the investigation of contamination removal from the atmosphere; the latter is not of radioactive but of meteorological character. The mechanism of radioactive atoms capture by aerosols, cloud, and precipitation particles is described in detail. The possibility of artificial air-cleansing from radioactive admixtures is considered. (tr-auth)

35338 AIRBORNE FISSION PRODUCTS RELEASED DURING CUTTING OF IRRADIATION FUELS. Yamamoto, Hozumu; Matsui, Hiroshi (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri, 4: No. 1, 32-7(Mar. 1969). (In Japanese).

Metallurgical tests on irradiated natural uranium fuels of the JAPCO's Tokai reactor were carried out at the Hot Laboratory, JAERI. During cutting, fission products in the fuel were dispersed inside the hot cell in the form of airborne material, and were released to the stack. The concentration of airborne fission products in the hot cell, the exhaust ducts, and the stack were assessed by the air sampling. Dispersion factor, removal efficiency of the exhaust air filtering system, and release fraction from the stack for fission products were obtained by air sampling. It was found that the dispersion factor depends on the volatility of each fission product, for example, 4.4×10^{-3} and 2.0×10^{-3} for ^{131}I and ^{137}Cs, respectively, and varies with cutting procedures. Removal efficiency of the exhaust air filtering system was found to be 80% for ^{131}I and about 97% for other fission products. Distribution of airborne fission products collected in three types of sampling medium, i.e., cellulose-asbestos filter paper (HE-40), charcoal-impregnated filter paper (CP-20B), and charcoal cartridge are also described. (NSA of Japan)

35339 FALLOUT FROM CHINESE NUCLEAR WEAPONS TESTS. Fahland, J. (Univ., Mainz). Z. Naturforsch., 24a: 653-9(Apr. 1969). (In German).

Short-lived radionuclides were measured in fallout from Chinese nuclear tests. The measured yield ratios of the nuclides ^{95}Zr, ^{111}Ag, ^{115}Cd, ^{156}Eu, ^{237}U, and ^{239}Np were corrected for fractionation effects and compared to calculated ratios. Free parameters of the calculation such as most frequent neutron energy, time integrated neutron flux, and fission material were adjusted by means of a least square criterion. For the tests 2, 3, 5, and 7 the most frequent neutron energy was found to be 5 keV. The corresponding Maxwellian neutron fluxes were within 10^{21} and 10^{24} n/cm^2. In addition, 14-MeV neutron fluxes within 10^{19} and 10^{22} n/cm^2 had to be assumed. The analysis yields as average of the converted fission material a mixture of ^{235}U and ^{233}U with 7 to 99% of ^{235}U. The fractionation of ^{140}Ba in surface bursts corresponded to that in air bursts. (auth)

35340 VARIATIONS IN ARTIFICIAL AND NATURAL RADIOACTIVITY IN REGENSBURG. Roczník, Karl. Meteorol. Rundsch., 22: 13-16(Jan.-Feb. 1969). (In German).

The concentrations of radioactivity in the atmosphere and precipitation in the Nuremberg-Regensburg area were reported for the period from 1957 to 1968. Measurement problems encountered were described. The monthly average β activity ranged up to 12 pCi/m^3. For 12 measurement stations located in the area the mean value of artificial β activity in precipitation was as high as 2000 pCi/l of water, and the cumulative β activity from precipitation ranged up to 550 mCi/cm^2, with annual precipitation of up to 800 l/m^2 at a single station. The radioisotopes identified in the precipitation varied quantitatively, and at Koenigstein typical annual average values were from 0.1 to 5.8 pCi/l for ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{140}Ba, ^{141}Ce, ^{144}Ce, ^{91}Y, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{131}I, and ^{125}Sb. Atmospheric artificial radioactivity ranged up to more than 6 pCi/m^3 annually. (BBB)

Mineralogy and Exploration

Refer also to abstracts 35325, 35332, 35333, 35490, 35493, 35505, 35506, 35511, and 35512.

35341 (STI/PUB-198) NUCLEAR TECHNIQUES AND MINERAL RESOURCES. Proceedings Series. Proceedings of the Symposium Held in Buenos Aires, 5–9 November 1968. (International Atomic Energy Agency, Vienna (Austria)). Mar. 1969. 555p. (In French and English). (CONF-681117). IAEA: $13.00; Austrian Schillings 336,–; £5.8.4; F.Fr. 63,70; DM 52,–.

Thirty papers were presented at the conference. A separate abstract was prepared for each paper. (R.C.K.)

For abstracts of individual papers see: 34993, 34994, 35012, 35014–35016, 35043–35046, 35326–35328, 35331, 35345–35348, 35388, 35431, 35490–35493, 35505, 35511, 35512, 35535, 35538, and 35539.

35342 NEW FRENCH URANIUM RESOURCES. S. Afr. Mining Eng. J., 79: 1328-30Dec. 6, 1968).

The Arlit area deposits of Niger represent the largest U discovery in the French area and are considered comparable to the U.S.A.'s Colorado Plateau as one of the richest U ore provinces in the world. The southwestern quadrant of Niger is the most promising prospecting province. Paleozoic traits are regarded favorably because no volcanism has taken place in more recent eras. Discovery of large U ore reserves will alter the economics of transportation. Work at first demonstrated the presence at Azelick of a substantial reserve, 2 million tons U ores, with an average assay of 6.5 lb/ton. The 1964 to 65 studies pinpointed another deposit at Madaouela. Core-drills were regionally sunk into the beds of fossil torrents, lying often enough under thick overburden. These holes for geological information uncovered in 1965 a considerable deposit at Arlit assaying a mere 2.5 lb of metal per ton, but characterized by an almost total lack of $CaCO_3$ and lying 100 to 120 ft below the surface. The reserves of the Arlette area, covering Km^2 has been put at 20,000 ton concentrates, carrying 70% U metal. The existence of several secondary ore bodies has been proven at nearby Ariane, Arnold, and Arelequin. Plans call for the provision in 1970 of a pilot treatment plant, with an initial design capacity of 200 ton U metal per year. The grade of the local reserve will probably warrant increasing capacity to a final 2,000 tons by 1975. A mining township for 5,000 to 6,000 working men and their families will be provided. When the Arlit complex is in full operation, its output will not only meet all French U metal requirements, but also leave a 400 to 500 ton yearly surplus available for export. (BBB)

35343 CONTINUING UPWARD TREND IN THE URANIUM INDUSTRY. Guenzel, H.; Knoerr, B. Metall, 23: 173-7(Feb. 1969). (In German).

Results of recent uranium explorations in the USA, Canada, and Australia are discussed. Explorations in Africa and South America are also considered. Effects of reserves on the price of U_3O_8 are discussed. (M.C.G.)

35344 URANIUM DEPOSITS IN THE HOYA DEL LOBO COMPANARIO (BADAJOZ). Ramirez, E. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 12: 453-68(Sept.-Oct. 1968). (In Spanish).

The uranium deposits in the Hoya del Lobo Companario were explored by aerial prospecting, on the ground by mechanical methods in one of the two mineralized deposits, and by excavations in the other deposit. The geological surroundings are described. The tectonic picture and the characteristics of the deposits were determined. The mineralizations of the deposits were analyzed. The possible origin of the deposits is discussed. (J.S.R.)

35345 TECHNIQUES CURRENTLY USED IN URANIUM PROSPECTING IN CANADA. Little, H. W.; Smith, A. Y. (Geological Survey of Canada, Ottawa). pp 131-45 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The sequence of existing practice in the search for uranium deposits in Canada begins with the establishment of a factual classification of types of uranium deposits and the criteria for recognition of the geological environment favorable to each type. The next step is the careful appraisal of geological maps and reports to determine regions and, more specifically, rock formations in

which these criteria exist. Guidelines in the selection of such areas were given in a recent Geological Survey paper by S. M. Roscoe. In most areas, once a favorable region or formation is selected, initial field investigation is preceded by an airborne scintillometer or airborne gamma-ray spectrometer survey. Detailed geological mapping is usually done, particularly by the larger companies, with special attention to the cause of anomalies. The form of geological studies is dependent on the type of uranium deposit; in the Elliot Lake area sedimentological studies comprise the main guidelines in the search for ore whereas structural interpretation is the keynote in such areas as Uranium City. Detailed scintillometer grid surveys on the ground are used subsequently to pinpoint the targets to be surface trenched or diamond drilled. The drilling pattern is also governed by the type of deposit. Down-hole scintillometer probes are used to extrapolate data obtained by more costly chemical assays. Research is being conducted, both by private industry and by the Geological Survey of Canada, into improved design and sensitivity of airborne gamma-ray spectrometry, and airborne magnetometers. The Geological Survey is testing AFMAG equipment, and plans to cover the Uranium City area, where pitchblende-bearing veins are in or close to faults. Geochemical research is being undertaken on the behavior of uranium ions, in stream sediments, in soils, and in surface waters, relative to their use in prospecting for uranium deposits. Recent analyses for radon in surface waters has shown a closer relationship between radon anomalies and uranium deposits than uranium anomalies in surface waters. Radon has also been used successfully to trace dykes covered by glacial overburden. Both uranium content of stream sediments and radon content of surface waters are being used by prospectors and companies as tools in uranium prospecting. (auth)

35346 USE OF FIELD GAMMA-SPECTROMETRY IN THE EXPLORATION OF URANIUM AND THORIUM DEPOSITS IN SOUTH GREENLAND. Loevborg, L. (Danish Atomic Energy Research Commission, Risoe, Denmark); Kunzendorf, H.; Hansen, J. pp 197-211 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The gamma-spectrometry method for field determination of uranium and thorium has been studied on the basis of 69 single measurements with a portable gamma-spectrometer in the Ilímaussaq intrusion, south Greenland. This intrusion is composed mainly of peralkaline syenites such as naujaites, lujavrites, etc. The lujavrites, especially, are characterized by large contents of uranium, thorium, and other rare elements. The average contents of uranium and thorium in the lujavrites found in the northernmost part of the intrusion are 575 and 1920 ppm respectively, and the average value of the Th/U ratio is 2.5. The maximum contents determined so far are 0.3% U and 1.3% Th. The radioactive minerals comprise a uranium-rich variety of monazite, steenstrupine, eudialyte and thorite(?). These minerals are unevenly distributed in one and the same rock type. Radioactivity also occurs in pigmentary material as a result of adsorption of uranium to iron oxides. The portable gamma-spectrometer consisted of a scintillation detector equipped with an uncollimated 2-in. diam. × 2-in. NaI(Tl) crystal and a single-channel pulse-height analyzer. While recording the field gamma-spectra the crystal was placed about 12 cm from the surface of the rocks. Rock samples from the field localities were crushed and spectrophotometrically analyzed for uranium and thorium. The gamma-spectra of the crushed samples were at the same time measured in the laboratory. For each field or laboratory gamma-spectrum the count-rates in two energy bands covering the 1.764- and 2.615-MeV total absorption peaks were determined. Both the field and the laboratory gamma-spectrometer data were correlated with the sample contents of uranium and thorium on the basis of linear regression analysis. The results obtained in the treatment of the laboratory gamma-spectrometer data indicated that ^{238}U and ^{232}Th were both in secular equilibrium with their daughters. The fluctuations of the field gamma-spectrometer data about the expected mean values of these data were very large, and were ascribed to the heterogeneities characterizing the distribution of uranium and thorium in the rocks. (auth)

35347 USE OF THE METHOD OF RECORDING FISSION PRODUCTS IN INSULATING MATERIAL TO STUDY URANIUM AND THORIUM DISTRIBUTION IN ROCKS AND MINERALIZATIONS. Sircana, Silvia; Gioria, G. (CNEN, Rome). pp 255-268 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969. (In French).

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The distribution of radioactivity in rocks and mineralizations can be studied by observing the path of gamma rays in the emulsion of nuclear photographic plates. However, there are several drawbacks to this method, e.g., the long exposure time for rocks of low radioactivity, the difficulty of distinguishing between uranium and thorium, and the influence of the radioactive equilibrium state of the sample on the results of the measurement. The method adopted in this study, however, which is based on recording U and Th fission fragments, can be used directly for distinguishing the distribution of U from that of Th, since their fissioning is brought about by neutrons of very different energy. Moreover, the result is independent of the radioactive equilibrium state of the sample and the time required for the measurement is always fairly short. The characteristics of a number of fission fragment detectors (nuclear plates, Makrofol, Mylar, ordinary glass and muscovite mica) were compared. The use of nuclear plates was found to give rise to serious complications, since the gamma radiation present in the nuclear reactor, which is used for inducing the fission of U and Th, produces a general blackening of the plate which makes it impossible to distinguish the fission fragment tracks clearly. On the other hand, the other detectors studied, all of which are insulating materials, are capable of recording only particles of higher mass and are completely insensitive even to very large doses of gamma radiation. The tracks recorded by these detectors can be made visible in the optical microscope by suitable chemical treatment. Among the products examined, Makrofol would appear to be the most suitable insulating material and it was used for studying uranium distribution in thin sections and in polished sections of rock. This method, which is especially simple and fast, can also be used for analysis of U and Th content in rock samples and fractions of monominerals. In view of the small amount of material required for analysis and the fact that the sample need not be destroyed, as well as the speed with which the technique can be carried out, the method is very attactive. The counting of the tracks under the microscope, which is the longest operation, can be automated if the method is used for routine measurements. (auth)

35348 INFLUENCE OF BOREHOLE CONSTRUCTION ON THE RESULTS OF SPECTRAL GAMMA-LOGGING. Czubek, J. A. (Inst. of Nuclear Research, Krakow). pp 37-53 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

In quantitative interpretation of gamma-logging results the absorption of gamma-radiation in drilling fluid, casing tubes, cement or in the mud cake must be taken into account. This absorption is generally described as the so-called transmission factor (T) which is the ratio of the radiation passing through the absorbers in the borehole in relation to the incident beam of radiation from the rock. Transmission factor T considered for a given photon energy E is called the spectral transmission factor T(E). If the intensity of gamma-radiation above some energy level E_p is measured, the integral transmission factor $T(E_p)$ intervenes in quantitative interpretation. Up to now the spectral transmission factor T(E) was given theoretically using the absorption of primary radiation in the borehole absorbers, which was equal to the consideration of the function $\exp[-\mu(E)r]r^{-2}$ as an elementary function of absorption of the narrow beam of gamma-radiation (r is the distance between the considered elementary radioactive volume αV and the observation point, $\mu(E)$, the attenuation coefficient of the considered medium for photons having energy E). The results for the transmission factor T(E) for this elementary function were too low in comparison with the experimental ones. To obtain good agreement between the theory and the experiment one must scattered gamma-photons. It is the aim here to derive the formulas for the T(E) factors for the cylindric and plane absorbers. Comparison of the theoretical values of T(E) with the experimental ones, obtained in the uranium ore model, for the iron and aluminium absorbents of different thicknesses, gave an excellent agreement between the theory and experiment in the whole range of the photon energy. Special nomograms for the rapid calculation of the T(E) values are given. (auth)

35349 AN ORIENTATION STUDY OF THE URANIUM DISTRIBUTION IN LAKE WATERS, BEAVERLODGE DISTRICT, SASKATCHEWAN. Macdonald, John A. (Eldorado Mining and Refining Ltd., Montreal). Quart. Colo. Sch. Mines, 64: 357-76 (Jan. 1969).

The Beaverlodge U district was surveyed to evaluate surface water sampling as a method of delineating regions of epigenetic pitchblende mineralization. Deterioration studies revealed that the chemical parameters of pH, bicarbonate content, specific conductance, and U content were sufficiently stable to allow analytical work to be performed in a central lab. In 13 control lakes, with

the exception of the spring breakup period, there was no significant variation in U content of lake water which can be attributed to seasonal temperature changes or precipitation. Although seasonal variations in the pH and bicarbonate content do occur, these changes do not affect the U solubility. Correlation studies indicated an increase in the specific conductance of lake water in the vicinity of mineralized areas. This resulted from increased bicarbonate content of the surface waters and reflected the carbonate-pitchblende association characteristic of deposits in the area. Lake water assays show that the Beaverlodge U district is delineated by an analytical plateau of 0.9 ppB U_3O_8, approximately twice the regional background value of 0.4 ppB U_3O_8. Numerous peaks occurring within this analytical plateau define zones of pitchblende mineralization. Replicate sampling of anomalous areas from year to year revealed a high degree of reproducibility. These results confirm the reliability of hydrochemical methods in delineating zones of epigenetic pitchblende mineralization within the Precambrian Shield. (BBB)

35350 URANIUM DISTRIBUTION IN SEPARATED CLINOPYROXENES FROM FOUR ECLOGITES. Condie, Kent C. (Washington Univ., St. Louis); Kuo, C. S.; Walker, R. M.; Rama Murthy, V. Science, 165: 57-9(July 4, 1969).

Uranium concentrations and distributions in separated clinopyroxenes of eclogites from four different sites have been studied by the fission track method. Types of uranium occurrences included inhomogeneously distributed clusters, line concentrations at cracks, and uniform distributions in the body of the mineral. Different grains from the same sample generally vary by factors of 2 to 4 in uniformly distributed uranium concentration. Samples from different locations vary in their average uniformly distributed uranium concentration by a factor of approximately 1000 (that is, from 0.01 to 20 parts per billion of uranium). The degree of homogeneity also varies markedly from one site to the next. The clinopyroxenes from the only oceanic locality studied (Salt Lake Crater) contained both the largest concentration of uranium (15 to 20 ppB) and the most uniform uranium distribution. The results suggest that, if total uranium concentrations in eclogitic clinopyroxenes are less than a few parts per billion, much if not most of the uranium may occur as contaminants along cracks or in microinclusions of unknown origin. (auth)

Oceanography

Refer also to abstract 35013.

35351 GEOCHEMISTRY OF URANIUM IN THE BALTIC. Baturin, G. N. (Inst. of Oceanology, Moscow). Geochem. Int. (Engl. Transl.), 5: 344-8(1968).

Translated from Geokhimiya, No. 3, 377-81(1968).

Uranium abundance was determined in sediments from the Baltic Sea. U ranges from 1 to 4 ppm in coarse-grained inshore sediments to 5 to 20 ppm in fine-grained deep-water sediments. The U content is correlated with the content of organic carbon. (auth)

35352 TRANSPORT OF RADIOACTIVITY IN THE OCEAN. James, L. R. (Naval Radiological Defense Lab., San Francisco); Mikhail, S. Z.; Schrock, V. E. Trans. Amer. Nucl. Soc., 12: 7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35353 SCAVENGING OF NUCLEAR FISSION PRODUCTS BY SEAWEEDS FROM SEA-WATER. Parekh, J. M.; Talreja, S. T.; Bhalala, B. J.; Doshi, Y. A. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). Curr. Sci. (India), 38: 308-10(July 5, 1969).

A method for removal of radioactive fission products (^{90}Sr, ^{137}Cs, ^{106}Ru, ^{131}I, and ^{65}Zn) from seawater specially meant for desalination and drinking purposes, using marine and freshwater algae, was tried. It is shown that about 15% of the radioactivity can be removed from contaminated seawater by selecting the appropriate algal species for each of the radioisotopes. (M.C.G.)

35354 URANIUM AND RADIUM IN THE SURFACE LAYER OF OCEANIC SEDIMENTS. Kuznetsov, Yu. A.; Simonyak, Z. N.; Lisitsyn, A. P.; Frenklikh, M. S. Geochem. Int. (Engl. Transl.), 5: 306-13(1968).

Translated from Geokhimiya, No. 3, 323-33(1968).

A study was made of the spatial distribution of U and Ra in the surface layer of Indian Ocean sediments. Eighteen of the 50 samples contain Ra deposited directly from the water. Ra is extracted from the water by sorption on particles. U coprecipitates with dead organisms, phosphates, and hydroxides of Fe and Mn. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 35376, 35455, 35552, and 35707.

35355 (PNE–611) SEISMIC INTERFERENCE AND RECIPROCITY FOR THE H E ROW CHARGE. Loux, P. C.; Murphy, J. R. (Environmental Research Corp., Alexandria, Va.). Dec. 31, 1968. Contract AT(29-2)-1163. 36p. Dep. CFSTI.

Project Dugout was a chemical explosive row charge cratering experiment in hard rock conducted to extend knowledge of row cratering phenomenology to a hard rock medium. Recorded Dugout strong motion seismograph data explore the questions of seismic interference and reciprocity. The expectation of linear relationships for the seismic motion resulting from energy imparted from each of the row charge elements is challenged. Even so, the linear relationships are tested with Dugout data in the interest of developing techniques for refined predictions of seismic effects from row charges. Neither interference nor the reciprocity phenomena are clearly exhibited in the Dugout data, but these results are shown to be inconclusive due to inappropriate test data. (auth)

35356 (PNE–1103) GEOLOGIC INVESTIGATIONS AND ENGINEERING PROPERTIES OF CRATERS. Project PRE-GONDOLA I. Fisher, Paul R.; Kley, Ronald J. (Army Engineer Nuclear Cratering Group, Livermore, Calif.); Jack, Harold J. (Army Engineer District, Omaha, Nebr.). Feb. 10, 1969. 82p. Dep. CFSTI.

The results of preshot and postshot geologic and engineering properties investigations performed in conjunction with the Project Pre-Gondola I cratering experiment series are presented. The Pre-Gondola I series consisted of the detonation of four 20-ton HE charges at varying depths of burst in highly over-consolidated Bearpaw clay shale at Fort Peck, Montana. The unweathered Bear-paw is a massive dark grey bentonitic clay shale. Alluvial and glacial overburden materials of significant thickness were found only at the Bravo site. Depth of weathering at the four cratering event sites ranged from 9 to 15 ft. The weathered shale was fragmented near ground surface, becoming blocky with depth. The unweathered shale was moderately jointed. Free groundwater levels were variable and were significantly influenced by fracture permeability. Detailed surface and subsurface postshot investigations were conducted at the Bravo crater. Surface postshot investigations only were conducted at the other crater sites. Pre-Gondola II preshot investigations provided postshot rupture zone information at the Charlie crater site. The surface of the fallback and ejecta materials weathered markedly over the 7-month period between the detonation date and the initiation of postshot investigations. Bulk densities and bulking factors of ejecta and fallback material at the Bravo crater are given. Significant permanent subsurface displacements and blast-induced fracturing extended to a distance of 250 ft, at ground surface, from the Bravo SGZ. Blast-induced fracturing extended to a distance of 400 ft from the Charlie SGZ. (auth)

35357 (PNE–5004-F) CONSTRUCTION TECHNIQUES AND COSTS FOR UNDERGROUND EMPLACEMENT OF NUCLEAR EXPLOSIVES. Hair, J. L. (Army Engineer District, Fort Worth, Tex.). Apr. 1969. 291p. Dep. CFSTI.

For Army Engineer Nuclear Cratering Group, Livermore, Calif.

Available methods and techniques currently being used in big hole (30-inch diameter and larger) drilling, tunneling, and conventional shafting are discussed. Big hole drilling methods include churn drilling, auger drilling, calyx drilling, and rotary drilling. Of these, auger drilling is the most economical for holes to depths of 200 feet in soft material, and rotary drilling is by far the best choice for depths in excess of 150 feet. Rotary drilling is not limited to any specific material type or hole size and therefore is the most adaptable method. The drill strings, drill bits, and circulating equipment are ordinarily designed specifically for big hole work. Typical input power ratings for the rigs range from 225 hp (drive-in rigs) to 1625 hp (stationary rigs), depending on the diameter and depth of hole. Borings from 36 to 72 inches in diameter are currently being drilled to depths exceeding 6000 feet with modified oil-well drilling equipment. Discussions of mining and shafting include the conventional cyclic method of drilling and blasting as well as the mechanical mining methods. With the cyclic method the average rate of advance for tunnel bores 8 to 12 feet in diameter appears to be about 10 to 12 feet per 8-hour shift, assuming average rock conditions. Average rate of advance for 2- to 3-compartment shafts appears to be about 6 to 8 feet per day. Mechanical tunneling methods are being used in both soft and hard rock. Rate of advance for mechanical mining ranges from 8 to 10 feet per hour in soft rock and 2 to 5 feet per hour in hard rock. Preliminary cost estimates for drilling large diameter holes are included. An analysis is described of conventional tunneling costs, mechanical tunneling costs, and cost factors involved in sinking shafts by conventional methods. A brief summary of the equipment requirements and costs necessary to rotary drill large diameter holes to depths of approximately 5000 feet are outlined. (J.C.W.)

Facilities and Equipment

Refer also to abstracts 35558, 35980, 36076, 36114, 36663, and 36817.

35358 (EUR–4190, pp 255-74) PRESSURE MEAUREMENT ON SILOS. Pieper, K. (Technische Hochschule, Brunswick (West Germany)). (In German).

Instrumented models were developed (base 70 × 70 cm, height 5 m) to enable all silo loads to be measured simultaneously, i.e., horizontal, wall friction and vertical loads. So far the measurements carried out on the models show that the exponential function on which the new German Standard DIN 1055 Bl. 6 is based is correct. It was proved, furthermore, that the discharge pressures are considerably higher than the filling pressures but that the maximum pressure curve can also be represented by an exponential function. Silo loads were found to be independent of the rate at which the silo is filled and emptied. On the other hand, the silo loads proved to be heavily dependent on the location of the discharge orifice within the cross-section. Wall roughness is an important factor only if it becomes high in relation to grain size. It was demonstrated that the roughness of corrugated sheet walls is so great that wall friction corresponds approximately to the angle of internal friction. The behavior of powdered solids, which produce very high pressures on quick filling, was investigated. As the material settles, however, the silo pressures fall very sharply so that for this condition the specifications of the German Standard are somewhat too high. The pressures occurring when powdered solids are homogenized with air were also measured. The homogenization pressure corresponds to the fluid pressure of the powder/air mixture. Measurements were also performed on the large pressure stresses arising on the collapse of internal arches such as form in cement clinkers when stored in silos. (auth)

35359 (EUR–4190, pp 403-22) STUDIES IN THE GEOMETRY OF RANDOM PACKING. Bernal, J. D.; Finney, J. L. (Birbeck Coll., London (England)).

Geometrical studies of randomly close packed arrays of equal spheres have been made, with particular reference to the structure of the liquid state. A mathematical description of the array was formulated and the general packing problem investigated. Physical models of random close and loose packed arrays of equal spheres were constructed, and their coordinates measured. Attempts to describe the structure of the array have so far been concentrated on the close packed system of about 0.63 density. The distribution of faces of the 5 polyhedra and their topology were investigated, with interesting results for packing in general. By measuring polyhedron volumes, a distribution function of local density was obtained, showing variations from 0.57 to 0.70, with an overall average of 0.634. These are compared with the density of a crystal close packing of 0.74. It was also shown that the density spread is drastically reduced when the density is measured over the first neighbors, to 0.62 to 0.65. Other proximity cell characteristics showed similar changes. Further work is intended using a larger (~5000 spheres) sample, and it is hoped to look at the wall effect, whereby crystalline order can penetrate into the sample. Samples are also being generated using computer techniques. By this means, the work will be extended to different densities and to mixtures. (auth)

35360 (EUR–4190, pp 505-16) ON THE INFLUENCE OF FRICTION IN MODEL STUDIES ON THE MECHANICS OF PEBBLE BEDS. Bedenig, D.; von der Decken, C. B.; Engel, R. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Juelich (West Germany)).

The influence of friction on absorber rods freely inserted into a pebble bed is reported. The results in test rigs of different scale showed discrepancies. Results of friction measurements are presented and an attempt is made to explain the discrepancies. (auth)

35361 (JINR-P13-4474) UNIFIED FILM TRANSPORT MECHANISM (UFT) OF THE CAMERA FOR WORK WITH THE 50 MM NONPERFORATED FILM. Maly, M.; Belyakov, S. F.; Vyskochil, S.; Malek, N.; Saksl, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 18p. (In Russian). Dep.

A film transport mechanism for a camera, intended for use in bubble and spark chambers in dangerously explosive conditions as well as in a strong magnetic field, is described. The drive of the mechanism is pneumatic, the maximum size of the frame is 150 × 50 mm. The data necessary for designing the apparatus using UFT-50 are presented. (auth)

35362 (JUL-579-FN) CONSTRUCTION OF A FACILITY FOR IRRADIATION WITH ELECTRONS AT LOW TEMPERATURES. Hemmerich, Johann (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik). Mar. 1969. 57p. (In German). Dep.

A facility was constructed in which samples could be irradiated with high electron doses at 4.5°K. The cooling of the samples is done by direct contact with liquid helium. The coolant circuit was maintained by a He refrigerator with a cooling output of 160 W at 4.5°K. For the homogeneous irradiation of samples with high utilization coefficient of the total beam, the electron source of the 3-MeV Van de Graaff accelerator was modified and a beam guide system with quadrupole lens was developed for adaptation of the beam spot to the respective sample form. Beam current densities of 100 amp/cm^2 with a homogeneity ≥ 10% over 2 cm^2 sample surface could be obtained. In low temperature irradiations with this facility defect concentrations of 2.7×10^{-3} could be detected in Pt and of 2.4×10^{-3} in Cu. The effect of the defect concentration on the defect structure was investigated. (tr-auth)

35363 (ORO-3411-12(Pts.1 and 2)) A STUDY OF THE OPERATING CHARACTERISTICS OF THE HEAT PIPE. PART I. AN ANALYTICAL MODEL FOR THE PREDICTION OF OPERATING LIMITS OF HEAT PIPES. PART II. CAPILLARITY IN POROUS MEDIA. Final Report. Ferrell, J. K.; Cosgrove, J. H.; Carnesale, A.; Schoenborn, E. M. (North Carolina State Univ., Raleigh. School of Engineering). Apr. 30, 1969. Contract AT-(40-1)-3411. 50p. Dep. CFSTI.

An analytical model is presented based on fundamental mass, heat, and momentum balances in the wick. It relates the maximum heat input to the fluid and wick characteristics and to the inclination of the pipe with respect to gravity. The model indicates that the critical parameters and operating characteristics are the capillary forces in the wick, pressure drop through the wick, and the operating temperature of the heat pipe. Maximum heat inputs in two experimental heat pipes were determined using packed beds of monel particles as wicking material and water as the working fluid. The agreement between the experimental results obtained and those predicted using the analytical model was excellent. (auth)

35364 (ORO-3411-12(Pt.3)) STUDY OF THE OPERATING CHARACTERISTICS OF THE HEAT PIPE. PART III. VAPORIZATION HEAT TRANSFER FROM FLOODED WICK COVERED SURFACES. Final Report. Ferrell, J. K.; Alleavitch, J. (North Carolina State Univ., Raleigh. School of Engineering). Apr. 30, 1969. Contract AT(40-1)-3411. 158p. Dep. CFSTI.

The mechanism of vaporization heat transfer on a system with a fluid-wick combination that had well-defined geometric parameters and physical properties has been examined. The experimental apparatus consisted of a horizontal, stainless steel surface with a bed of monel beads of various sizes and depths in contact with it. The beds were covered with 2- through 4-inch depths of distilled water. The experimental data indicated very strongly that, in contrast to ordinary pool boiling, the heat transfer coefficient was very nearly constant for all heat fluxes below the critical value and that the latter is reached when the capillary forces are no longer sufficient to maintain liquid in contact with the heated surface. Analytical models were derived for both the heat transfer coefficient and the critical heat flux and are shown to be in excellent agreement with the experimental results obtained. (auth)

35365 (Y-1683) THE HOT ISOSTATIC PRESSING EXPERIENCE OF THE OAK RIDGE Y-12 PLANT. Neeley, A. C.; Pfeiler, W. A.; Valentine, C. K. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 18, 1969. Contract W-7405-eng-26. 13p. Dep. CFSTI.

Approved designs of hot-gas autoclaves previously used the principle of minimizing gas convection currents. The hot isostatic pressing facility at the Oak Ridge Y-12 Plant is designed so that convection currents are maximized in the contained vessel. Argon is used to enhance this effect. (auth)

35366 A MICROCAGE FOR RADIOASSAY OF LIVE INSECTS WITH AUTOMATIC COUNTING EQUIPMENT. Hayes, J. T. (Univ. of Georgia, Athens). Int. J. Appl. Radiat. Isotop., 20: 603-4(Aug. 1969).

A restraining cage for insects on individual leaves of a plant, developed by Rhodes and Luckmann (1967), was modified to suit use with a counting planchet. It has the advantages of being easy to make, with readily available materials, while allowing sufficient ventilation so as not to reduce insect longevity. The drawback of counting variability due to movement of the insect can be at least partially overcome by reduction of the space available to the insect to that only slightly larger than the insect itself. (auth) (UK)

35367 THE 2000 CURIE ^{60}Co GAMMA-RAY IRRADIATION FACILITY FOR BIOLOGICAL STUDIES. Yamagata, Hirotada (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 47: 67-76(Jan. 1969).

A gamma irradiation facility for biological studies, providing 2000 Ci ^{60}Co source, was installed at the Faculty of Agriculture of Kyoto University in 1967. This facility is composed of a building, a gamma irradiation system and an environment regulation system. The irradiation field shapes nearly a semicircle and is equally divided to three irradiation rooms. All the rooms are separately regulated on the condition of temperature, humidity, and illumination. Two control rooms, being adjusted to the same conditions as those of irradiation rooms, are installed for analysis of radiation effects. The source strength of 2000 Ci is divided into 20, 180 and 1800 Ci, which can be selected by remote operation. Three lead filters operated remotely are equipped for each irradiation room, and each of them attenuates dose rate to one tenth. Temperature of the irradiation room is adjustable within the range of 5 ~ 15°C for one room and 15 ~ 30°C for the other two rooms, and can be automatically changed with timers. Humidity of those rooms is kept within 50 ~ 90%. Illumination intensity of each room can be controlled to 5000, 500, and 0 lux at the floor. Lighting time also is chosen with timers. (auth)

35368 SUPPORT FOR NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,408,833. Filed July 7, 1964.

A support for a fuel element is described comprising a metal part in the form of a spider positioned at the lower end of an annular sleeve which surrounds the fuel element. The support has a central portion on which the fuel element rests and a plurality of lateral arms the extremities of which are attached to the sleeves by a screw and nut arrangement or by welding. The support may be formed by cutting out and bending a metal plate. Preferably the fuel element is carried on the central part by means of a graphite seating block provided with slots receiving the lateral arms. (NPO)

35369 NUCLEAR FUEL CARTRIDGE. (to Commissariat a l'Energie Atomique). French Patent 1,447,428. Filed June 18, 1965.

A fuel can is described which is in alignment with identical cans in the channel of a reactor. The can comprising at least one plate of clad fuel material substantially parallel to the axis of the channel, the maximum length of the plate along the axis is at the most equal to one half the overall length of the can. If only one plate is used it preferably has the form of a spiral coiled around the axis of the can. Several flat or concentric annular plates may be used all being located in the same axial portion of the can. Concentric annular plates may be supported by a tube which is secured at both ends to the sleeve of the can and has axial corrugations facing a counterbore of the sleeve in its median portion. The tips of the corrugations are in abutting contact with the outer fuel plate. (NPO)

35370 SUPPORT SYSTEM FOR A NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,461,663. Filed Oct. 28, 1965.

A system for supporting a fuel element which is provided with a metal can having radially extending longitudinal centering partitions is described. The system comprises a number of longitudinal bars made of a low-neutron absorption substance, each bar being provided with a longitudinal groove slidably engaged by one of the partitions. The bars are rigidly interconnected by two metal members which are placed one at each end of the bars and are provided with a flange engaging in a slot at each end of the bar. The members are interconnected by rods which are disposed either at the base of the longitudinal grooves or in a bore extending through each bar. The lower metal member carries a metal collar having a central recess provided with a saddle on which the lower end of the fuel element rests. Preferably the bars are made of graphite and up to four can be provided arranged symmetrically about two perpendicular axes. The fuel element has four centering partitions with each pair of adjacent partitions bounding a sector of the can surface which has two sets of parallel cooling fins oppositely inclined. (NPO)

35371 PROCESS FOR THE RECUPERATION OF METALS INCORPORATED IN A BURNABLE MATERIAL. (to Commissariat a l'Energie Atomique). French Patent 1,439,162. Filed Apr. 6, 1965.

A process for the recovery of small quantities of expensive metals, e.g., U and Pu, incorporated in or adhering to a burnable material, e.g., graphite is described. The process comprises roasting the material in air; passing the reaction gases through a bed of a granulated inert material, e.g., Al_2O_3, to retain the metals or their oxides entrained in the gases; and dissolving the metals or oxides in a suitable solvent, e.g., HNO_3 containing, if necessary, a small quantity of HF or $Al(NO_3)_3$. In a modification a mixture of the burnable material and the inert material is continually passed through the incinerator. Preferably the roasting process is initiated in air, preheated at about 400°C and if necessary enriched with O_2, and carried on after the beginning of the exothermal combustion in cold air if necessary diluted with N_2. An apparatus for effecting the process is shown in detail in an accompanying drawing. (NPO)

35372 ASSEMBLING NUCLEAR FUEL PLATES. (to Commissariat a l'Energie Atomique). French Patent 1,478,392. Filed Jan. 12, 1966.

A fuel assembly comprising a plurality of equally spaced vertical fuel plates, the longitudinal edges of which are engaged in vertical grooves provided in two support plates perpendicular with respect to the main plane of the fuel plates is described. In order to fix the edges in the grooves a wedge is driven into the material of the support plates between the grooves, causing deformation of the material in such a way that it is pressed sidewards against the adjacent fuel plates thus firmly anchoring them to the support plates. A tool for this operation is described in detail. It consists of a support part, an eccentric bearing, the wedge, and a lever system by which the eccentric can be rotated, putting the wedge into operation. (NPO)

35373 IMPROVEMENT IN CONTAINERS OF FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Compagnie Francaise Thomson-Houston). French Patent 1,388,801. Filed Dec. 5, 1963.

A container is described which, instead of having an annular cross-section, the container is star-shaped. In this way the heat transfer from the center of the fuel to the coolant is improved. (NPO)

35374 METHOD OF SPACING APART PARALLEL NUCLEAR FUEL RODS. (to Siemens-Schuckertwerke Aktiengesellschaft). French Patent 1,450,219. Filed Oct. 15, 1965.

Parallel fuel rods are spaced apart by means of annular members of oval shape which are slipped on the rods and then fastened in an oblique position, e.g., by brazing. Preferably the inner surfaces of the members are machined to match the surface of the rods. The spacing members may be brazed together at their points of contact so as to form a grid unit. Different forms of spacing members are shown in an accompanying drawing. (NPO)

35375 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,389,912. Filed Apr. 1, 1964.

A fuel element is described with the outer wall of the fuel container provided with helical cooling fins. At chosen intervals two adjacent fins and the channel in between are replaced by one fin of corresponding thickness, which bears protrusions, to which longitudinal baffles are fastened, extending nearly to the wall of the coolant channel. (NPO)

35376 FOUR INCH APERTURE VALVE (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1857).

20 drawings

A 4 in. ball valve is described which is used in the underground nuclear explosion program to protect experimental equipment from high velocity debris or postshot radioactive contamination. Maximum closing time is 0.030 sec. For vacuum use, the valves must be modified by adding a vacuum O-ring seal. For details see TID 4100 Suppt. 53. (F.S.)

35377 SUPPORT MEMBER FOR A NUCLEAR FUEL CARTRIDGE. (to Commissariat a l'Energie Atomique). French Patent 1,408,832. Filed July 7, 1964.

A self-centering support member for a fuel cartridge is described comprising a star-shaped metal member disposed at the bottom of an annular sleeve surrounding the cartridge and having a central part on which the cartridge rests and which is provided with a number of lateral spokes of sheet-metal, the spoke ends contacting the sleeve and the spokes being of bent form to provide vertical cartridge-centering strips, the top ends of which are secured to a cylindrical ring which rests on a shoulder in the internal surface of the sleeve. Preferably the spokes comprise lateral extensions such that the spokes once bent can slide in longitudinal grooves extending along generatrices of the sleeve. (NPO)

35378 SUPPORTING STRUCTURE FOR NUCLEAR FUEL ASSEMBLY. (to Babcock and Wilcox Ltd.). French Patent 1,488,035. Filed July 22, 1966.

A supporting structure for a nuclear fuel assembly is described which includes a grid comprising a plurality of fuel element ferrules which are joined to one another, each ferrule being adapted to embrace a fuel element to position the fuel elements laterally relative to each other, and a support member to which the grid is connected by means of tabs carried by at least some of the ferrules distributed round the periphery of the grid, the tabs being folded so that the support member lies between the tabs and the grid. Preferably each of the tab-carrying ferrules is provided with two tabs folded towards one another, one tab of each pair being provided with a recess and the other being provided with a tongue lying in the recess, the tongue being welded to the tab containing the recess. (NPO)

35379 THERMIONIC FUEL ELEMENT FOR NUCLEAR REACTOR. (to Siemens-Schuckertwerke Aktiengesellschaft). French Patent 1,466,406. Filed Nov. 25, 1965.

A fuel element is described comprising thermionic diodes connected in series, and nuclear fuel disposed inside the emitter electrodes. To prevent deformation of the latter, and in consequence deformation of the narrow annular gap between the electrodes, caused by the growth of the fuel during operation, a cylindrical space is provided between the fuel and the emitter, the space accommodating the expansion of the fuel. In order to maintain thermal and electrical contact between the fuel and the emitter the space is provided with metallic wool or a corrugated metal-sheet. In a modification the fuel is divided into a plurality of spaced radially extending sheather sectors, the thermal and electrical contact being established by an extension of each sheath. (NPO)

35380 DEVICE FOR DISPENSING RADIOACTIVE XENON GAS. Steimann, K.; Aspin, N. (Univ. of Toronto. Hospital for Sick Children, Toronto). Radiology, 92: 396-7(Feb. 1969).

A device designed and constructed to readily dispense ^{133}Xe from gas cylinders which have internal volumes from 10 to 50 cc at a gas pressure of approximately 10 mm Hg is described. High purity CO_2 is used to fill the ^{133}Xe cylinder to a pressure of three atmospheres. This enables a small quantity of the ^{133}Xe-CO_2 gas mixture to be readily withdrawn from the cylinder through a micrometer needle valve. Carbon dioxide is used as the pressurizing gas since a Xe-CO_2 mixture can be more readily dissolved in saline for intravenous injection than can a Xe-air mixture. (W.H.K.)

35381 APPARATUS FOR EXAMINATION OF SINGLE CRYSTALS BY SCATTERED PROTONS. Livesey, R. G.; Butcher, G. (Edwards High Vacuum International Ltd., Crawley, Eng.). pp 203-6 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.

See CONF-680401.

Protons scattered from the surface layers of single crystals show a spatial distribution which depends on the crystal structure. An apparatus is described which was developed to exploit this phenomenon for the examination and orientation of single crystals and thin crystalline films. The main vacuum chamber of the apparatus is of stainless steel, with a target manipulator, fluorescent screen, and ion source and gun fixed to demountable flanges. Positive ions are extracted from a Penning discharge, accelerated to 20 keV and directed at an acute angle to the surface of the target. A specially designed manipulator, which employs coaxial rotary shaft seals, provides angular adjustment of the target about two perpendicular axes. Particles scattered from the surface layers of the target impinge on a fluorescent screen which is held at a distance of 1 to 3.5 cm from the target. The screen can be examined visually or photographed by an external camera. Initial results indicate that "blocking" patterns can be produced from a variety of crystals and that the technique is relatively insensitive to pressure conditions in normal dynamic vacuum apparatus. (auth)

35382 THE HOT-CELL AT THE JUAN VIGON CENTER. CONSTRUCTION AND INSTALLATION OF A 1,000 CURIE (1 MeV) [SOURCE] IN THE METALLURGICAL CELL OF THE BUILDING. Crespi Gonzalez, M. Alicia; de la Camara, S. Norena (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 12: 438-50(Sept.-Oct. 1968). (In Spanish).

The construction of the hot-cell at the Juan Vigon Center, the structure of the hot-cell itself, and the special installations are described. The heavy concrete shielding and the storage facilities are also discussed. The ventilation and filtration installations of

the hot-cell are described along with the installation for radioactive waste water. (J.S.R.)

35383 STRESS ANALYSIS OF REACTOR GRAPHITE STRUCTURES. Rashid, Y. R.; Chang, T. Y. (Gulf General Atomic, Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 316 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35384 PRESSURES AND JETS FROM WATER IMPACT UPON OPEN STRUCTURES. Wright, R. W. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 363 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35385 HIGH-FLUX INDUCTION HEATER FOR SODIUM CORROSION TESTING. Wachtel, S. J.; Romano, A. J.; Klamut, C. J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 125-6 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35386 CAPACITY EXPANSION OPTIMIZATION IN A GROWING NUCLEAR FUEL FABRICATION INDUSTRY. Homan, F. J.; Washburn, T. N. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 25 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35387 A SERIES OF TELEVISED NUCLEAR ENGINEERING EXPERIMENTS. Babb, Albert L.; Woodruff, Gene L.; Garlid, Kermit L. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 12: 18-19 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35388 DYNAMIC TESTING OF MINERAL PROCESSING EQUIPMENT USING RADIOISOTOPES. King, R. P.; Woodburn, E. T.; Colborn, R. P.; Edwards, R.; Smith, W. E. (Univ. of Natal, Durban, S. Africa). pp 117-27 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Processing of low grade ore deposits can only be economic if the processing is performed efficiently. This implies a thorough understanding of the process so that, for example, proper control and operating strategies may be adopted, and in this connection the dynamic response is an important aspect of a process. Radioisotopes are particularly valuable as tracers for the determination of the dynamic response. The dynamic testing of a mineral flotation cell in which a phosphate mineral is separated is described. The dynamic response of the solid phase in the cell was obtained by following the response to an injection of irradiated phosphate ore (^{32}P is the active constituent). The response of a liquid phase was obtained by following the response to an injection of short-lived ^{137}Ba produced by milking a ^{137}Cs "cow". Details of the dynamic testing procedure and the production of the isotopes are discussed. The important question of the random noise associated with the isotope decay process is considered, and the design of a suitable digital filter for data smoothing is presented. The usefulness of such a filter is demonstrated by considering the frequency response of a typical process. (auth)

35389 POWER REACTOR FUEL. Rose, Roar (Institutt for Atomenergi, Kjeller, Norway). Tek. Ukebl., 116: 424-8 (Apr. 10, 1969). (In Norwegian).

The work being carried out at Institutt for Atomenergi in the nuclear fuel field is reviewed on the background of the potential industrial activities following the domestic and foreign requirements for initial and replacement fuel charges in the years to come. The Institute's work comprises at present pilot production of fuel assemblies for water-cooled reactors, related work to improve production processes, and fuel assembly R & D concentrated around the international fuel irradiation program of the Halden Reactor. The R & D work supports the general trend in direction of increased heat ratings and simplified design for power reactor fuel. (auth) (Norway)

35390 LONG TERM FINANCIAL ASSESSMENT OF NUCLEAR CONTAINERSHIPS. Kesterman, F. (Marine Administration, Washington, D. C.). Nucl. Eng. Int., 14: 93-7 (Feb. 1969).

A financial analysis is provided for nuclear propulsion economics which can be quantified using 1968 costs as documented in the Advanced Nuclear Cargo Ship Study prepared by the General Dynamic Corp. for the Maritime Administration. (auth) (UK)

35391 PORTABLE CESIUM IRRADIATOR (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1891).

13 drawings.

A portable self-contained, lead shielded irradiator is described that weighs ~19 tons and occupies ~72 ft of floor space. A source is employed that moves from its storage cask into the irradiation chamber and back with each radiation cycle, eliminating a package carrier system. The 100,000 Ci source consists of 28 portable standard BNL ^{137}Cs sources arranged horizontally in 2 source plaques covering an area 19 in. by 27 in. The source plaque is contained in a lead shielded cask attached to the irradiation chamber during operation. The cask can also be used as a shipping cask. Mechanical and pneumatic interlocks monitor the movements of the source plaque and door preventing accidental exposure. The source plaque and shielding doors are controlled and powered by compressed air. The source may be anchored to the deck of a ship, railroad car, or truck trailer. (For details see TID-4100 Suppl. 54). (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 35363, 35364, and 35384.

35392 (EUR-4190, pp 63-77) JENIKE'S METHOD FOR THE LAYOUT OF BINS AND HOPPERS. Schwedes, J. (Karlsruhe Univ. (West Germany). Institut fuer Mechanische Verfahrenstechnik). (In German).

With the help of soil mechanics, continuum mechanics, and the theory of plasticity, a theory for the gravity flow of frictional cohesive bulk solids out of bins and hoppers has been developed. To deform a consolidated sample of material plastically there are different states of stress possible. These states of stress can be measured in Jenikes Shear Tester. The stresses at the point of failure can be drawn in a σ, τ-graph, where τ is the stress necessary to shear a sample under a normal pressure σ. From the resultant curve, which is called yield locus, the strength f_c of the material can be determined. The strength is the major stress in a free surface of a material, which was consolidated under the pressure σ_1. To calculate the stress at incipient failure and in steady state flow, 5 equations are necessary. The equations are derived from the stress equilibrium, the relations for the yield loci, and a relation between the bulk density and the major stress σ_1. The most important obstructions against a free flow of bulk solids are a stable arch (doming) or a rathole (piping) within the material. If a stable arch has been formed, there will be a stress σ_1, at the abutments of the arch. The stress is proportional to the span of the arch. A graph of the consolidating pressure σ_1 can be derived from the stress field, a graph of the strength f_c can be determined from shear tests, and a graph of the stress σ_1 can be calculated from the force equilibrium of a stable arch. A flow-no flow criterion can now be postulated: A stable arch cannot form if $f_c < \sigma_1'$. The aperture of the hopper must therefore be at least at the height h, where $f_c = \sigma_1'$. (auth)

35393 (EUR-4190, pp 79-115) THE CRITICAL STATE CONCEPT AND THE USE OF SHORT-WAVE LENGTH RADIATION TO STUDY THE ONSET AND MAINTENANCE OF FLOW IN GRANULAR MATERIALS. Roscoe, K. H. (Cambridge Univ. (England). Dept. of Engineering).

The development of the critical state at which granular materials will flow is presented in outline. It is shown that most cohesionless granular materials have to expand before flow can occur and in doing so have to pass through a condition in which they can resist higher imposed stresses than they are to sustain when flow has commenced. Furthermore such materials tend to fail in thin rupture zones, the thickness of which is a function of the grain size of the material rather than of the size of the sample under investigation. The material in these rupture zones has a smaller bulk density than the surrounding material. New methods of studying the development and shape of these zones, in fact of obtaining successive pictures of the pattern of strain throughout the entire mass of a granular material, have been developed. These methods are briefly described and the relative merits of using x-ray, γ-ray, or neutron sources with various combinations of detectors are discussed. (auth)

35394 (EUR-4190, pp 117-19) X-RAY INVESTIGATIONS OF FLOWING POWDERS. Cutress, J. O. (National Coal Board, Nuneaton (England). Char Briquetting Group).

X-ray radiographs of polystyrene powder have been obtained in the course of an investigation into their mechanism of flow from hoppers. Whenever a radiograph was taken of a powder after flow out of an aperture, distinct and discontinuous interval surfaces of low powder density were seen. It is shown that the prop-

erties of these surfaces are consistent with their being along the slip directions predicted for failure of a plastic material. A cine film was used to show the visual flow through the sides of the hoppers. A cine X-ray film was used to show the discontinuous lines forming and moving during the flow, and the stationary pattern when flow is stopped. (auth)

35395 (EUR-4190, pp 121-34) RESIDENCE TIME DISTRIBUTION OF GRANULAR MATERIALS FLOWING THROUGH CYLINDRICAL VESSELS. Novosad, J. (Ceskoslovenska Akademie Ved, Prague).

A method to calculate the distribution of residence times of granular materials flowing through cylindrical bins is discussed. The method is based on experimental results of the kinematics of flowing granular materials. Colored layers of sand were fed into a dismantable, cylindrical container simultaneously to discharge the material until a stationary state was reached. The outlet then was closed and the whole container was dipped into liquid paraffin. After cooling the container walls were removed and the casting cut vertically. The borders between the different color layers showed the flow behavior. The velocity of the single grains near the wall was decreasing exponentially with decreasing height. A simple model for the moving material was suggested and a relation to calculate residence times was derived. For experimental measurements of residence times a layer of chemically marked sand was used. The agreement of experimental data and calculated results was satisfactory. (auth)

35396 (EUR-4190, pp 205-19) SOME PARAMETERS TO CHARACTERIZE THE FLOW BEHAVIOUR OF SPHERICAL AND NONSPHERICAL MATERIALS. Reisner, W. (Technische Hochschule, Clausthal-Zellerfeld (West Germany). Institut fuer Bergbau). (In German).

The problems of flow of bulk materials in a hopper, bin, bunker or silo were investigated. Balls are supposed to be an ideal bulk material and gravel, quartz, granite and gritstone to be real bulk materials. When a material is flowing out of a bin the rate of discharge is greater for a spherical than for a non-spherical material as long as the relation between diameter of the outlet and the grain size is the same. The rate of discharge becomes larger with decreasing grain size the more the particles of the bulk material are approaching the ideal shape of a sphere. In the case of a conical bottom, the greater the inclination of the bottom the greater the rate of efflux becomes. The rate of discharge is getting lower as the shape of the material becomes irregular. Because of the different flowability a dimensionless factor was developed. It is the factor the mean efflux rate of an ideal bulk material (balls) has to be multiplied with to obtain the efflux rate of a certain bulk material. With reference to this factor the influences of internal friction, void ratio, and bulk density of different materials were investigated. The mean efflux rate increases with decreasing internal friction. The same tendency exists for the void ratio. With decreasing angle of friction between the bulk material and the wall of the container the efflux rate becomes greater. These parameters are also investigated as a function of different conical bottoms, which are important for greater inclinations. (auth)

35397 (EUR-4190, pp 221-40) THEORETICAL AND EXPERIMENTAL INVESTIGATIONS ON SEGREGATION EFFECTS IN STORED MATERIALS. Matthee, H. (Technische Hochschule, Clausthal-Zellerfeld (West Germany). Institut fuer Bergbau). (In German).

Segregation effects in stored pebble beds with respect to application of the results in scaled-down bins and hoppers to full scale ones were investigated. Segregation is considered as part of the complex flow behavior of granular materials from hoppers. With granular materials consisting of two fractions of different sizes, segregation can be described approximatively by physical laws. The influences of different factors on the segregation were investigated. A segregation factor is defined and discussed with respect to the standard derivation of statistical mathematics. This segregation factor is a function of the parameters influencing segregation. Because of the large numbers of different parameters such as geometrical form of hopper and outlet, size distribution, specific weight of the material, friction within the material itself and between material and wall, inertia and gravity which mainly are influencing the flow behavior of a granular material, the experimental investigations only could be performed in scaled-down models. The results of these investigations have to be transformed on industrial hoppers making use of similarity analysis. (auth)

35398 (EUR-4190, pp 275-94) PRESSURES AND FLOW IN COAL BUNKERS. Walker, D. M. (Central Electricity Generating Board, Bristol (England)).

A theory for the derivation of the approximate stresses that would occur within a granular material in reasonably steep smooth bunkers during the filling and discharge operations, and to establish criteria for arching over the outlet, is given. Wall pressure measurements made on experimental bunkers holding up to 5 tons of fine coal are reported and for the steeper bunkers, at least, agreement with theory is good. A ring shear cell being used for measuring the flowability characteristics of powders is described and it is shown that the results can be used in conjunction with the theory to account approximately for the magnitude of the critical outlet sizes for arching. (auth)

35399 (EUR-4190, pp 321-42) PRESSURE DISTRIBUTION INSIDE MODEL STORAGE HOPPERS DURING DISCHARGE OF GRANULAR MATERIALS. Perry, M. G.; Handley, M. F. (Sheffield Univ. (England). Dept. of Fuel Technology and Chemical Engineering).

The internal forces developed during gravity flow of particulate material from storage hoppers are of practical importance of their relationship with internal flow patterns and ultimately with the pressures at the retaining walls of the hopper. Classical formulae of Janssen and Airy are applied to calculate the wall pressures in the vertical section of the hopper. Certain types of flow can produce wall pressures far in excess of the values predicted by these formulae. Jenike has used classical soil mechanics theory to formulate design criteria and to calculate the pressures in the converging section of hoppers. A combination of these formulae constitute a theoretical pressure distribution evaluation for the complete hopper. A pressure sensitive radiation source was used to measure the pressure during flow of granular material. The experimental pressures are compared with those predicted by theory. Pressure measurements were made by allowing the source, which is small (1 cm diameter by 2 cms long), compared with the dimensions of the model hoppers used, to flow with the granular material. Two materials were used, sand and limestone, and four perspex model hoppers. By modifying the source, positioned measurements were made which enabled pressure distribution fields and flow patterns to be drawn. In comparing these results with the early classical results it was found that the vertical pressures obtained during flow were in excess of those predicted. Near the outlet the pressures in the mass flow hoppers were in good agreement with those predicted by the Jenike design data. The pressures at the entry to the converging section of the hopper, particularly the horizontal circumferential pressure are however widely divergent from those predicted by the Jenike design theory. The vertical pressures are shown to decrease before entry to the converging section of the hopper, and in the case of the mass flow hoppers the position at which this decrease occurs is related to the dynamic arch. (auth)

35400 (EUR-4190, pp 453-62) EXPERIMENTAL METHODS TO MEASURE THE FLOW BEHAVIOUR OF A PEBBLE BED. Bedenig, D.; von der Decken, C. B.; Rausch, W.; Schmidt, G. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Juelich (West Germany)).

To measure the velocity distribution of the balls in model cores of pebble bed reactors direct and indirect methods can be used. Direct methods use some kind of radiation to determine positions of test balls. Indirect methods consist of measurement of integral quantities, for instance of residence times, to calculate approximate velocities at any point of the core. The direct methods include the method of marking test balls with radioactive tracers and the so-called absorption method which was used extensively in glass bead models. Experimental techniques developed in this respect are reported and characteristic results are demonstrated (with cine films). The indirect methods include parameter studies of residence spectra. Typical results of residence spectra are shown. (auth)

35401 (EUR-4190, pp 463-77) STUDIES OF PARAMETERS AFFECTING THE FLOW BEHAVIOUR OF A PEBBLE BED. Bedenig, D.; Schmidt, G. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Juelich (West Germany)).

A series of parameter investigations to study the influence of each parameter on the flow behavior of pebble beds including core geometry, was made. The residence spectra method was used. (J.C.W.)

35402 (EUR-4190, pp 479-90) A THEORETICAL MODEL FOR CALCULATING THE FLOW BEHAVIOUR OF A PEBBLE BED AND ITS APPLICATION TO THE CORE OF THE THTR PROTOTYPE. Bedenig, D. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Juelich (West Germany)).

A theoretical model is described which allows the calculation of the pebble bed flow behavior using certain experimental data. In this model (stream tube model) the pebble bed flow is considered as incompressible laminar flow presupposing the knowledge of the ball paths. The experimental data necessary to calculate the velocity distribution within the core are called characteristic functions. To show the validity of this model experimental data are compared with results of a computer

program which is based on the stream tube model. The agreement is rather good and demonstrates the adaptability of the theoretical model. The velocity distribution and some other important functions of the pebble bed flow are discussed. (auth)

35403 (LA-4172) FLOW AND THERMAL CHARACTERISTICS OF HYDROGEN NEAR ITS CRITICAL POINT IN A HEATED CYLINDRICAL TUBE. Wilson, Mahlon T. (Los Alamos Scientific Lab., N. Mex.). May 1969. Contract W-7405-eng-36. 144p. Dep. CFSTI.

Thesis. Submitted to Univ. of New Mexico, Albuquerque.

The flow conditions and mechanism of hydrogen near its critical point in a heated cylindrical tube were investigated. The experimental apparatus consisted of a 1.376 in. ID 180 in. long, electrically heated vertical tube. Thermocouples and potential taps were located along the tube. An instrumented probe traversed the tube near the exit end. The probe carried a pitot tube, a thermopile, and a hot wire anemometer sensor. Dynamic pressure, temperature, and hot wire anemometer bridge average and RMS voltages were measured as a function of test section radius. The data were represented by empirical equations. A special boiling number was found to be effective in correlating temperature differences for pressures greater than the critical pressure. Correlations were also obtained as a function of reduced pseudocritical temperatures. With pseudocritical temperatures slightly less than one, dynamic pressure, temperature, and average hot wire current were more nearly constant with respect to radius than at other temperatures. "M" shaped velocity profiles were observed at pseudocritical temperatures above one. The experimental tests produced conditions at the probe in which the reduced temperature ranged from 0.66 to 1.22, the reduced pressure varied from 1.003 to 1.351, and the Reynolds number was from 4.0×10^5 to 3.2×10^6. (auth)

35404 (SC-CR-69-3059) MEASUREMENTS OF THE THERMAL CONDUCTIVITY OF SOILS TO HIGH TEMPERATURES. Final Report. Flynn, D. R.; Watson, T. W. (National Bureau of Standards, Washington, D. C.). Apr. 1969. Contract ASB48-6179. 105p. Dep. CFSTI.

For Sandia Labs., Albuquerque, N. Mex.

An apparatus is described which has been designed and built to enable measurement of the thermal conductivity of soils at hot face temperatures approaching 1700°C. The method utilizes radial heat flow through a hollow cylinder of soil contained between a central ceramic core and an outer water-cooled metal shell. Thermal conductivity values are reported for nine natural or artificial soils representative of subsoils found on most of the earth's surface. For each of these soils, measurements have been completed on two different specimens under particular but reproducible conditions of preparation. (auth)

35405 DEPENDENCE OF THERMAL CONDUCTION OF LEAD AND CAST-IRON PELLETS FROM TEMPERATURE. Vasil'ev, A. N.; Polekhina, T. K. At. Energ. (USSR), 26: 296-7(Mar. 1969). (In Russian).

A stationary spherical layer method was used for studying heat transfer of lead and cast iron spheres in the temperature range from 100 to 600°C. The maximum error for a single measurement of the heat transfer coefficient was 8.3%. The probable sphere diameter was determined by a selective method by constructing a frequency distribution curve by diameter for 100 spheres. Experimental data on the heat transfer as a function of the porosity were in good agreement with theoretical data calculated by the Bogolyubov formula. (R.V.J.)

35406 CRITICAL FLOW OF STEAM-WATER MIXTURES. Henry, Robert E. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 12: 353-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35407 CRITICAL FLOW DATA OF SODIUM LIQUID-VAPOR MIXTURES. Fauske, Hans K.; Quinn, Daniel J.; Jeans, William C. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 354-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35408 STOCHASTIC ANALYSIS OF NUCLEATE POOL BOILING. Ram, K. S. (Univ. of Cincinnati). Trans. Amer. Nucl. Soc., 12: 301(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35409 FISSION-FRAGMENT-INDUCED NUCLEATION OF BUBBLES IN SUPERHEATED WATER. Dietrich, L. W.; Connolly, T. J. (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 12: 301-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35410 COOLANT FLOW ANALYSIS IN SOME TYPICAL FUEL ELEMENT SUBCHANNELS. Szabados, L. (Central Research Inst. for Physics, Budapest); Grillo, P. Trans. Amer. Nucl. Soc., 12: 302-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35411 TRANSIENT FREE-CONVECTION HEAT TRANSFER IN LIQUID METALS IN VERTICAL RECTANGULAR CHANNELS. Heinisch, R. P. (Argonne National Lab., Ill.); Singer, R. M.; Viskanta, R. Trans. Amer. Nucl. Soc., 12: 303-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35412 AN EXPERIMENTAL STUDY OF INCIPIENT SODIUM SUPERHEATS. Holtz, R. E.; Singer, R. M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 304-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35413 DATA OF LIQUID FRACTION IN SODIUM LIQUID-VAPOR FLOW. Fauske, Hans K.; Quinn, Daniel J.; Jeans, William C. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 305(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35414 CONVECTION HEAT TRANSFER IN A HEAT-GENERATING FLUID. Nelson, M. E. (Univ. of Virginia, Charlottesville); Rust, J. H.; Iachetta, F. A. Trans. Amer. Nucl. Soc., 12: 306(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Isotope Technology

Refer also to abstracts 35326, 35391, 35452, 35471, 35472, 35744, 35892, 35893, 35986, 36000, 36216, and 37358.

35415 (AD-687131) RADIOISOTOPIC POWER GENERATORS: STATE-OF-THE-ART REPORT. Berlandi, Francis J.; Kawahara, Francis K.; Kim, J.; Schrock, V. E. (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 7, 1968. 340p. CFSTI.

A state-of-the-art compilation of radioisotopic power generators is summarized with respect to fuels, conversion devices, and overall system design performance through 1966. The fuel data are listed according to isotope mass number. The conversion devices discussed are thermoelectric, thermionic, Brayton, Rankine, and Stirling cycles. The systems section lists the major features that characterize RPG units in use in this country. (auth) (USGRDR)

35416 (KURRI-TR-10, pp 150-9) PREPARATION OF NUCLEAR-SPECTROMETRY SOURCES. Iwata, Shiro (Kyoto Univ. (Japan)). (In Japanese).

The subject of nuclear spectrometry was once almost the sole domain of nuclear physicist, but recently chemists started to participate in this field because many of the techniques associated with the necessary source and preparation required knowledge of chemical techniques. This activity was spearheaded by the Berkeley group. As the physical measuring instruments are being improved, the source preparation is unable to keep up with the measuring techniques, even when chemical aid is evoked. As a matter of fact, the field of chemical techniques must be overhauled; therefore the subject of source preparation and some of its associated problems are reviewed. The area in which chemistry plays important roles, such as target preparation, nuclear reactions, chemical separation (radiochemistry), and source mounting are discussed. (TTT)

35417 (MMM-3691-47) DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. SNAP-21 Program, Phase II. Quarterly Report No. 11, January 1-March 31, 1969. (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). Contract AT(30-1)-3691. 156p. Dep. CFSTI.

EQUIPMENT AND PROCEDURES — testing and performance of SNAP-21 power conditioning
HASTELLOY X — fabrication of SNAP-21 vacuum system inner liner of, hydroforming method for
MATERIALS TESTING — equipment and methods for SNAP-21 thermoelectric generator components
SHIELDING — fabrication and testing of SNAP-21 biological
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-21) — thermoelectric generator for, assembly, performance, and testing of
THERMAL INSULATION — fabrication and assembly of SNAP-21

THERMOELECTRIC CELLS — fabrication, testing, and performance of 10 W SNAP-21
THERMOPILES — performance of six-couple SNAP-21 (R.C.K.)

35418 (UJV-2115-Ch) ACCELERATOR PRODUCED ISOTOPES. Svoboda, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1968. 44p. Dep.

A review of radioisotopes commercially produced by cyclotrons is given along with some properties and the name of the producers. Data on specific cyclotrons for radioisotope production are tabulated. The advantages of cyclotron-produced isotopes and reactor-produced isotopes are evaluated. (122 references). (J.C.W.)

35419 FORATOM REPORT ON URANIUM ENRICHMENT. Com. Naz. Energ. Nucl., Notiz., 15: No. 3, 89-101(Mar. 1969). (In Italian).

The full text of the Foratom report on uranium enrichment in Europe is presented. The report recommends that the construction of a uranium enrichment plant in Europe be considered. The European needs for enriched uranium and the economic aspects of uranium enrichment in Europe are discussed. (J.S.R.)

35420 RADIOISOTOPE THERMOELECTRIC GENERATORS UTILIZING ISOTEC LIGHTWEIGHT PANEL TECHNOLOGY. Bradshaw, George B.; Steeger, E. J. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 5-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35421 A SURVEY OF THE REENTRY BEHAVIOR OF PLUTONIUM DIOXIDE MICROSPHERES. Pyatt, David W.; Ostrowski, Peter P.; Weiner, Robert I. (Weiner Associates, Inc., Baltimore). Trans. Amer. Nucl. Soc., 12: 6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690906.

35422 TAILORED SPECTRA FROM 14-MeV NEUTRON SOURCES. Smith, Darryl B.; Menlove, H. O. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 218(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35423 REMOVAL OF THE ELECTRICAL CHARGE ON POWDERS BY β-RAYS. 2. Sakanushi, Katsuhiro (Research Inst. of Industrial Safety, Tokyo). Powder Technol., 6: No. 2, 59-61(Mar. 1969). (In Japanese).

The removal by β-rays of the electrical charge of powders (wheat flour) falling from a shifter was studied. The powder charged by passage through the netting fell directly onto a Faraday cage. The rectangular β-ray source (^{90}Sr) was placed about 100 cm above the top of the Faraday cage, either parallel or at right angle to the direction of powder falling. The density of electrical charge was varied by changing the mesh of the netting. The effect of charge removal was about 5% greater with the parallel position of the source than with the perpendicular, due probably to the longer time of powder irradiation. In general, the amount of remaining charge was larger as the falling charge was increased. When the falling charge was small, the powder was electrified to the negative charge, on the strength of the β-rays themselves. The effectiveness in charge removal was not dependent on the charge density. The remaining charge versus the distance of β-ray irradiation was largely influenced by the falling charge. It appears that, in normal conditions the mechanism of charge removal by β-rays is not essentially changed by the state of powder, i.e., stationary or moving. (NSA of Japan)

35424 VERY INTENSE NEUTRON SOURCE (VINS). Russell, G. J.; Brugger, R. M. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 285-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35425 A NEW ENCAPSULATION TECHNIQUE FOR ^{252}Cf SOURCES. Baybarz, R. D. (Oak Ridge National Lab., Tenn.); Peterson, J. R.; Knauer, J. B. Trans. Amer. Nucl. Soc., 12: 56-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35426 CLEAN ^{238}Pu FROM ^{237}Np IRRADIATION. Meichle, R. H.; Nosler, J. C. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 53-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35427 DESIGN AND FABRICATION OF AN ISOMITE(TM) PACEMAKER POWER SOURCE. Gasper, K. A.; Griffin, B. I.; Walker, J. C. (McDonnell Douglas Astronautics Co., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 50-1(June 1969).

35428 ^{238}Pu MATERIALS AS RADIOISOTOPIC HEAT SOURCES FOR HUMAN USE. Mullins, L. J.; Matlack, G. M.; Nance, R. L.; Metz, C. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 47-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35429 ENHANCING ORALLOY VALUES IN POWER REACTORS WHILE OFFSETTING THE DIFFERENT EFFECTS OF ^{232}U AND ^{236}U. Eschbach, E. A.; Young, J. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 37 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35430 IMPLANTABLE RADIOISOTOPE-POWERED CARDIAC PACEMAKER. Hursen, T. F.; Maurer, G. W. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 12: 49-50(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35431 NUCLEAR TECHNIQUES CURRENTLY USED IN OIL FIELD EXPLOITATION. Peteu, G. (Carottage and Perforation, Ploesti, Rumania). pp 383-96 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

There is general recognition at present of the contributions being made by nuclear methods to the operation of oil fields, as a means of providing information on the physical and lithographic properties of geological formations and also on the technological conditions under which deposits of hydrocarbons can be opened up and exploited. Nuclear techniques provide a wide variety of information which is very useful in all activities connected with the investigation and development of oil fields. A general survey is given of the present status and prospects of the techniques of nuclear geophysics, which are classified as follows: methods concerned with the investigation of geological formations, from the point of view of lithologic nature, content of clay, dolomite, anhydrite, etc., and based on the study of natural and induced radioactivity (making use of gamma and neutron radiation); methods concerned with petrophysical parameters (density, porosity, etc.), by means of which the collecting capacity of prospected geological formations can be qualitatively and quantitatively determined; methods for determining the nature of fluids present in deposits; and radiotracer methods, which are used extensively in the drilling, construction and operation of oil wells, and also in various techniques concerned with exploitation of deposits, secondary recovery, etc. An analysis is given of the main improvements that have been made in procedures, equipment and operational techniques; the prospects for modernizing radiometric methods used in geophysics for oil field operation are discussed. With regard to the future, it is considered that since nuclear methods have proved to be a valuable means of quantitative evaluation, it is to be expected that technological advances in instrumentation and the development of measuring techniques will make it possible to attain the highest possible degree of precision. Particular importance is given to the development of spectral analysis in the study of natural, scattered and induced gamma-radiation, and also to radioactive tracer techniques. It will be important to develop new neutron techniques for determining the nature of fluids in deposits; and increased consideration will have to be given to the theoretical study of the processes involved in the interaction of nuclear radiations and the highly complex physical medium represented by hydrocarbon deposits. (auth)

35432 RADIOATOMS IN NUCLEAR MEDICINE. Blichert-Toft, P. H. Goteborg, P. H. Blichert-Toft, 1968. 78p. Sw. Kr. 25. (NP-17944).

Decay schemes and decay characteristics of radioisotopes for use in nuclear medicine are presented. (W.H.K.)

35433 THE POLAR CAPS: EVIDENCE OF THE TERRESTRIAL ENVIRONMENT. Lorius, Claude. Sciences (Paris), No. 56, 40-52(Sept.-Oct. 1968). (In French).

Nuclear methods for dating ice samples are based on the abundance of isotopes contained in them, particularly ^{3}H, ^{210}Pb, ^{32}Si, and ^{14}C. Contamination problems with ^{3}H and ^{14}C dating are noted. The study of ^{32}Si is also affected by contamination from nuclear explosions, though the use of ^{32}Si as a dating device is so new for ice dating that many problems must be resolved (e.g., low yields of Si in ice) before the degree of perturbation of ^{32}Si levels by nu-

clear explosions is established. Possibly ^{39}Ar may also be used for dating. The rate of formation of ^{210}Pb from ^{222}Rn makes it of interest for dating; ^{210}Pb of artificial origin does not appear to exist, and so it is quite attractive from a fallout contamination viewpoint. Snow dating by fallout of artificial isotopes, principally ^{90}Sr and ^{137}Cs, is suggested. Use of ^{32}Si and ^{14}C in the study of glacier movements is described. Fluctuations of isotopic content with time (e.g., ^{210}Pb concentration in fresh snow) may have an external source. Attempted correlations with sunspots numbers are illustrated. The use of variations in abundance of natural stable isotopes (^{2}H, ^{18}O) for determining the history of ice deposition and movement is explained. (BBB)

35434 DETERMINATION OF THE WEIGHT OF THE STEEL INSIDE AN ELECTRIC FURNACE BY MEANS OF RADIOACTIVE ISOTOPES. Caldera, P. G. (Sorin, Saluggia, Italy); Pavesio, F.; Piccinini, S. Met. Ital., 61: 128-32(Mar. 1969). (In Italian).

A radioisotopic method for the determination of the weight of liquid steel in an electric furnace before pouring is described. The method is essentially one of dilution. A quantity of radioactive gold is introduced into the electric furnace and when it is uniformly distributed in the liquid steel bath, the dilution of the radioisotope is measured on a sample. From this dilution, the quantity of steel is determined. A prolonged experimental study permitted the optimization of the conditions for the application of the method and the evaluation within ±1% precision of the weight of the steel. The same method is under experimentation on the Martin furnace and is applicable to LD converters. (tr-auth)

35435 ISOTOPE TECHNOLOGY. Been, Ulf (Institutt for Atomenergi, Kjeller, Norway). Tek. Ukebl., 116: 460-4(Apr. 17, 1969). (In Norwegian).

Isotope technology has today wide application in many fields. A long series of radioisotopes with different properties is in use in the form of pharmaceuticals, chemicals, and radiation sources. Medicine, industry, and research are the main fields of application. The first part of the article gives a short account of this pronounced universal application of radioisotopes and isotope techniques. Then an account is given of the activities of the Isotope Laboratories at Institutt for Atomenergi. This work comprises the supply of radioisotope products of various kinds, service, and assignments for industry and research and development projects concerning the production and industrial application of radioisotopes and radiation. (auth) (Norway)

35436 REMOVAL OF THE ELECTRICAL CHARGE ON POWDERS BY β-RAYS. 1. Sakanushi, Katsuhiro (Research Inst. of Industrial Safety, Tokyo). Powder Technol., 6: No. 2, 52-8(Mar. 1969). (In Japanese).

The removal of β-rays of the electrostatic charge distributed over the volume of powders (wheat flour) was studied. The amount of this charge is determined by the balance of the charge due to friction of the spout and the powders on one hand and the leaking charge under the particular environment. The sources employed in the experiment were: ^{90}Sr(SIC-8), with 20 mc and maximum 0.545 MeV; and ^{147}Pm(PHC-15), with 20 mc and maximum 0.223 MeV. The distance of irradiation was 35 cm below the bottom of the volume of powders; the static electricity was measured with a Faraday cage. The results obtained are: the remaining charge increases proportionately with the original amount of charge; the removal effect vs the irradiation time is of an exponential nature; the ^{90}Sr with a larger energy is more effective for removing the charge than ^{147}Pm with less energy; the concentration of charges has no effect on charge removal; and the amount of remaining charge is not changed by the thickness of powder samples. (NSA of Japan)

Materials Testing

Refer also to abstracts 35388, 36104, 36223, and 36224.

35437 NUCLEAR POWER PLANTS. Booser, E. R. (General Electric Co., Schenectady, N. Y.). pp 44-1-13 of Standard Handbook of Lubrication Engineering. O'Connor, James J. (ed.). New York, McGraw-Hill Book Company, 1968.

The growing application of nuclear power plants for generation of electricity and for ship propulsion has created a number of new types of lubrication problems. First, radiation effects must be considered in applying lubricants to many plant components. Second, a combination of radiation with an unusual environment must be considered for devices operating in the water, liquid metal, hot gas, or other fluids used to carry heat out from the reactor. Finally, consideration must be given to improve reliability because of reduced accessibility to lubricants and lubricated equipment in locations where a failure could lead to serious consequences. Established lubricants and lubricant technology will serve most needs of turbines, generators, motors, hoists, and other plant accessories. Basic lubrication principles will also serve as useful guides for control-rod drives, for bearings operating in water or liquid metal, and for other unusual conditions peculiar to atomic plants. The effects of radiation on oils and greases, a general consideration of lubrication problems in nuclear power plants, and water and liquid-metal lubrication guides are discussed. (auth)

35438 PHOTOELASTICITY FOR THE IMPOSSIBLE JOBS. Dohrmann, R. J. Power Eng., 73: 34-5(July 1969).

Photoelastic studies of difficult or impossible-to-calculate areas give reliable indications of stress distribution. Latest techniques provide better analyses of complex geometries than do the available mathematical techniques. Photoelasticity provides data and guidelines whereby mathematical techniques can be verified, modified, or developed. Through these advances, designers can ensure the degree of reliability essential in stress analysis. The new applications of photoelasticity are discussed. (J.C.W.)

35439 METHOD OF AND APPARATUS FOR DETERMINING THE PRESENCE OF A TREATING MATERIAL IN A WORKPIECE. (to Gulf Research and Development, Co.). British Patent 1,156,584. July 2, 1969. Priority date July 6, 1965, United States.

A method is described for quantitatively determining the presence or absence of a treating material applied to a workpiece. A beam of thermal neutrons is projected through a test zone to irradiate the zone to induce scattering by the treating material of a portion of the beam. A signal is produced that is related to the thermal neutrons transmitted through the workpiece and the signal is collimated to reduce the scattered neutrons. The collimated signal is compared with a standard collimated signal obtained for a standardized workpiece to give a measure of the amount of treating material. An apparatus for carrying out the determination is described in detail. (B.L.M.)

35440 STANDARD HANDBOOK OF LUBRICATION ENGINEERING. O'Connor, James J. (ed.). New York, McGraw-Hill Book Company, 1968. 1048p. $27.50.

A separate abstract was prepared for one chapter on lubrication in nuclear power plants. The remaining 44 chapters discuss principles and engineering practices of lubrication and lubrication of specific equipment and in specific industries not within scope of NSA. (J.C.W.)

For abstract of individual chapters see: 35437.

Protective Structures

35441 GAMMA DIFFERENTIAL ENERGY FLUX AT SEVERAL ALTITUDES ABOVE AN AIR-GROUND INTERFACE FALLOUT FIELD. Buhl, A. R. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Trans. Amer. Nucl. Soc., 12: 374-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Radioactive Material Handling

Refer also to abstracts 37643 and 37644.

35442 FUNDAMENTAL ASPECTS OF THE CHEMISTRY OF PLUTONIUM. I. GENERALITIES AND PROBLEMS IN HANDLING THE ELEMENT. Perez-Bustamante, J. A. Energ. Nucl. (Madrid), 12: 471-85(Sept.-Oct. 1968). (In Spanish).

An introduction is presented to the basic chemistry of plutonium. In the handling of this element most difficulties are presented by the need for radiation protection and elimination of radioactive residues. The properties of the isotopes of Pu are described. The toxicity of the element is considered and means of protection are described. (J.S.R.)

35443 PROCESS FOR THE DESTRUCTION OF IRRADIATED LIQUIDS. (to Commissariat a l'Energie Atomique). French Patent 1,445,500. Filed Feb. 13, 1965.

A process for the disposal of irradiated liquids is described which comprises contacting the liquid with peat until maximum absorption is achieved, e.g., for a time ranging from 1 to 18 hours, and then heating the impregnated peat to a temperature, preferably below 1000°C, for a time sufficient to effect complete combustion. (NPO)

35444 CRITICALITY CONSIDERATIONS IN BASKET DESIGN FOR IRRADIATED FUEL SHIPMENT. Newlon, C. E. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 338-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35445 IRRADIATED FUEL SHIPPING: TODAY AND TOMORROW. Shappert, L. B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 22(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35446 THE ADAPTATION OF THE ATCOR CASK TO THE BONUS FUEL SHIPMENT. Dash, D. P.; Tolson, G. M.; Stout, F. W. Jr. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 28-9(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35447 THE FEASIBILITY OF INCORPORATING RADIOACTIVE WASTES IN ASPHALT OR POLYETHYLENE. Fitzgerald, C. L.; Godbee, H. W.; Blanco, R. E.; Davis, W. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 29-30(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35448 PROCESS FOR INJECTING RADIOACTIVE RESIDUES INTO THE SOIL. (to Marcel Masson). French Patent 1,443,938. Filed Mar. 12, 1965.

A process for disposal of radioactive residues is described which comprises dissolving or suspending the residues in a liquid and injecting the liquid into the soil under suitable pressure, the soil becoming hydraulically loosened by the liquid. (NPO)

Vacuum Engineering

Refer also to abstracts 35381, 37052, 37054–37057, 36088, 36089, 36141, and 36147.

35449 PROCEEDINGS OF THE FOURTH INTERNATIONAL VACUUM CONGRESS, MANCHESTER, ENGLAND, APRIL 1968. PARTS 1 AND 2. Conference Series No. 5 and 6, 1969. London, Institute of Physics and Physical Society, 1969. 827p. 250s. (In Several Languages). (CONF-680401).

The conference comprised 152 papers, arranged under the following sectional headings: Standards, units, and terminology; drying, chemical, and biological applications; sorption and desorption of charged and uncharged particles; surface phenomena; space simulation; particle accelerators and nuclear fission apparatus; electron tube systems and devices; mechanical and vapor pumps; ion pumps and getter pumps; sorption pumps and cryopumps; gas kinetics; vacuum metallurgy; vacuum deposition of thin films; total pressure measurement and vacuum gages; partial pressure measurements, gas analysis, and mass spectrometers; vacuum systems; specialized systems; materials and components; and education. A separate abstract was prepared for each of fifteen papers. The remaining 137 papers were not within scope of NSA. (UK)

For abstracts of individual papers see: 35381, 35450–35454, 36088, 36089, 36141, 36147, 37052, and 37054–37057.

35450 CRYOSUBLIMATION TRAP FOR EXTREMELY HIGH-VACUUM SYSTEMS. Holkeboer, D. H. (Aero Vac Corp., Troy, N. Y.). pp 405-8 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

A cryosublimation trap (CST) can extend the capability of a vacuum system to the 10^{-14} torr range without the use of helium or hydrogen cooling and without cooling the vacuum chamber below room temperature. The effectiveness of the CST depends on the sublimation of titanium on liquid-nitrogen-cooled baffles which are placed between the vacuum chamber and pumps to prevent the backstreaming of gases such as hydrogen from the pumps. By means of a CST with a 10-in. diffusion-pump assembly, pressures estimated at 3×10^{-14} torr were achieved. Addition of a liquid-helium-cooled baffle between the CST and vacuum chamber allows the production of pressures less than 1×10^{-14} torr. A smaller system achieved 6×10^{-13} torr without liquid helium. The effectiveness of the CST as a trap, as observed by measuring the pressure rise in the vacuum chamber when gases were introduced on the pump side of the unit, was shown by pressure ratios of 550 for hydrogen, 1990 for nitrogen, and more than 5000 for CO_2. (auth)

35451 CALIBRATION OF VACUUM GAUGES AT PRESSURES BELOW 10^{-10} TORR. Davis, W. D. (General Electric Research and Development Center, Schenectady, N. Y.). pp 605-8 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

A metal vacuum system for investigating the behavior of vacuum gages at pressures below 10^{-10} torr was constructed and its performance evaluated. An ultimate pressure of less than 1×10^{-13} torr was attained by using cryogenic pumping. The residual gas was primarily hydrogen. Measurements were made on a hot-cathode magnetron-type gage and on a commercial cold-cathode gage. A dynamic calibration method involving stepwise extension to the lowest pressure was used. The output current of the hot-cathode magnetron was linear with pressure down to the lowest calibration point of 4×10^{-13} torr. Indirect measurements indicated that this linearity extended down to the base pressure of the system. A collector-to-filament bias of 90 v was needed to prevent hot electrons from reaching the collector. At an emission of 1×10^{-8} A (magnetic field off), the sensitivity was 0.064 A $torr^{-1}$. The cold-cathode gage exhibited discontinuities, hysteresis, and oscillations in its output current at certain pressures, but the overall response varied as $P^{1.2}$. The sensitivity was 0.06 A $torr^{-1}$ at 4×10^{-13} torr. Mass-spectrometric measurements at 10^{-13} torr, using a conventional ion source, were hindered by outgassing and electron-induced ion desorption. A magnetron-type ion source greatly reduced this problem. (auth)

35452 IMPROVEMENT OF IONIZATION GAUGES EMPLOYING A RADIOACTIVE SOURCE: L'ALPHAVAC 500. Andrieux, P.; Iapteff, B. (Societe Generale du Vide, Choisy-le-Roi, France). pp 675-8 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969. (In French).
See CONF-680401.

A description is given of the Alphavac 500 ionization gage, which allows pressure measurements between 5×10^{-4} and 1,000 torr with a precision of ±3%. The gage comprises two sections, for pressures between 5×10^{-4} and 1 torr and between 1 and 1,000 torr. The radiation source employed is ^{241}Am. Particular points in the construction are that the low pressure collector is not directly exposed to the source, a reflector is employed behind the collector in order to augment the neighboring electric field, and a better-defined ionization volume is obtained. Details are given of sensibility, linearity, effect of signal amplitude, calibration of zero, etc., together with some results obtained. (UK)

35453 SNAP 8 VACUUM SYSTEM. Strahl, H. (Atomics International, Canoga Park, Calif.). pp 763-6 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

The SNAP (Systems for Nuclear Auxiliary Power) 8 Developmental Reactor vacuum system provides an environment simulating space for ground testing of the nuclear reactor. The system was designed to operate continuously for 10,000 hrs while maintaining a pressure less than 10^{-5} torr with the reactor operating in the vacuum chamber. The design objective of long-term uninterrupted operation is achieved by providing facilities to replace or repair components without a complete shutdown. A dual pumping system incorporates two complete sets of pumps and valves manifolded into a single high-vacuum duct and chamber. Preliminary tests indicate that the system is capable of achieving a vacuum of 10^{-7} torr with the vacuum chamber empty. (auth)

35454 ULTRA-HIGH-VACUUM SYSTEM FOR A REACTOR BEAM TUBE. Baltacis, E.; Dobrozemsky, R.; Kubischta, W. (Reactor Center, Seibersdorf, Austria). pp 767-71 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

For an experiment on free neutron decay it is planned to measure the energy spectrum of the decay protons which have energies of a few hundred electron volts. The decay protons will originate near the reactor core in a tangential beam tube. The spectrometer and detector unit will be placed 4 m from the reactor core outside the reactor shield. To reduce interactions with gas atoms, which would result in an energy-dependent transmission of the protons, a bakeable all-metal system is necessary. The baking temperature is limited to about 100°C by the presence of magnetic shielding material and by considerations of reactor safety. In the central parts of the beam tube the outgassing rates will be increased by the presence of γ and neutron radiation (dose rate about 10^8 RAD hr^{-1}). Since the conductance between this source of gas and the pump is only a few liters per second, it was necessary to investigate the reactor outgassing effect. The outgassing properties of aluminum under reactor irradiation after moderate bake-out procedures was measured. The outgassing data were obtained by the throughput method. A heavy increase of outgassing rates was observed. This increase was found to be caused mainly by γ radiation. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 35345 and 35346.

General Detectors and Monitors

Refer also to abstracts 35559, 35570, 35729, 35784, 36471, 36823, and 37613.

35455 (AD–684029) ANALYSIS OF SYSTEMS FOR THE RECORDING OF EXPONENTIAL SIGNALS. Talbot, R. V.; Shipman, J. R.; Huggin, F. E.; Dobbie, C. B. (Naval Radiological Defense Lab., San Francisco, Calif.). June 1960. 146p. (NRL–4354). CFSTI.

An analysis of the requirements of a recording system to be used in recording single nonrecurrent signals of the form K (exp (alpha t)) with the range of alpha being from approximately 1×10^6 to 20×10^6 per sec is presented. The recording of such signals is particularly important in nuclear measurements on atomic weapons. Particular attention is given to the response of the more important system components such as detectors, transmission lines, signal amplifiers and cathode-ray tubes. The capabilities and limitations of each are discussed. It is found that for a linear system the primary effect of each component is to cause a reduction in the relative amplitude of the signal, resulting in a reduction in the dynamic range of the system. Some attention is also given to the response of certain system elements to other type signals including impulse functions, step functions, ramp functions and sinusoids. The effects of nonlinear elements are considered rather briefly. From this analysis conclusions are drawn and recommendations made concerning the selection of the most suitable system elements and the arrangement of these elements. Where possible, suggestions have been given as to possible future developments. (auth) (USGRDR)

35456 (AERE-M–2193) BERYLLIUM: A REAPPRAISAL OF ITS USE IN NUCLEAR RADIATION DETECTORS. Howes, J. H.; Leake, J. W. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1969. 10p. Dep. CFSTI. UK 2s. 6d.

The use of beryllium for the construction of nuclear radiation detector bodies and as a vacuum tight envelope is reappraised in the light of present-day beryllium technology. Applications for neutron sensitive ionization chambers and proportional counters are considered and some preliminary results are given on low energy x rays using a gas-filled proportional counter with a body made wholly from beryllium, with a cylindrical wall thickness of 250 μm. (auth) (UK)

35457 (BNWL-SA–2150) INSTRUMENTS IN THE FIELD: USE, ABUSE, AND MISUSE. Kathren, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 11p. (CONF-690103–16). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

Advances in field instrumentation have been great over the past decade, providing the operational health physicist with a powerful armamentarium. However, even the most modern instruments have many limitations, and measurements must be made and evaluated in the light of these limitations, which include energy and angular dependence, response to pulsed sources, and effects of mixed radiation fields. The concept of surface dose rate, its meaning, use, and misuse, is examined in the context of operational health physics, and a practical method of measuring doses close to the source–air interface is discussed. (auth)

35458 (GEMP–699) NEUTRON DOSIMETRY CALCULATIONS FOR MULTIPLE-CYCLE IRRADIATIONS FROM SEVERAL DOSIMETERS INCLUDING ^{58}Ni. Hilf, C. L. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Sept. 6, 1968. Contract AT(40-1)-2847. 13p. Dep. CFSTI.

Solutions to the dosimetry equations are presented for the thermal neutron (n,γ) reactions in ^{59}Co and ^{58}Fe, and the fast neutron (n,p) threshold reactions in ^{58}Ni, ^{54}Fe, and ^{46}Ti. The mathematical relationships take into account multiple-cycle irradiations and the burn-up of the product isotopes. No correction factor is necessary when using the ^{58}Ni dosimeter since the isomeric state, ^{58m}Co, is taken into consideration for all irradiation and decay times. (auth)

35459 (ISS–68/45) PULSE SHAPE DISCRIMINATION CIRCUIT TO BE USED AT A HIGH ENERGY ACCELERATOR. Papadopoulos, L.; Bosio, C. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Dec. 19, 1968. 12p. Dep.

An apparatus for the pulse shape discrimination of differently ionizing particles, to be used at a high energy machine, is described. The circuit has four independent input, which are mixed and two output, one of which is linear. (auth)

35460 (JUL–582-ZE) POSITION-RESOLVING DETECTOR BANK FOR NEUTRON SCATTERING EXPERIMENTS. Abend, Klaus (Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Elektronik). Mar. 1969. 89p. (In German). Dep.

The development and construction of a large-surface detector bank for the simultaneous detection of the neutrons from a small-angle scattering device were described. After consideration of some alternatives to the structure of the detector bank, the construction of a detector surface with proportional counters was described. The Sistemich and Lauterjung position-resolving principle was used; this principle was previously not used for neutron detection. The counters were filled with BF_3 and had a resistance wire as collector. The resistance wire is connected to both ends of the counter and the ratio of the output signal at the counter is a measurement of the position of the neutron detection in the counter. By parallel wiring of at least 6 counters, a detector surface of 60×30 cm^2 was formed. The localizing information of each counter was fed on-line to a digital computer. This computer is also used for experimental control. It was shown that the proportional counters with resistance wire show a poor pulse height spectrum. The quotient picture of the counter signals can be resolved only with extreme specifications on the dynamics and the linearity of the analog pulse processing and the analog calculation system. In the longest counter a half-value width of the position resolution of 0.6 cm was obtained, which corresponds to a resolution of 1%. The position resolution obtained can be understood from the properties of the counters, range of the ionization particles in the counter, and the electronic characteristics of the system. The linear correlation between position-resolving signal and actual incident beam position is better than ±0.15 cm. (tr-auth)

35461 (KURRI-TR–10, pp 24-34) PROBLEMS IN HEAVY ION DISCRIMINATION. Imanishi, Nobutsugu (Kyoto Univ. (Japan)). (In Japanese).

"Heavy ions" is the term used for ions with atomic number above three. The detection of heavy ions differs from that of "light particles" (p,d) in two respects. The first is the great energy loss and the very short range, making it necessary to provide a suitable design to compensate for these factors. In the second place, it is important that heavy ions are only very infrequently stripped down to the bare nucleus. Their passage through matter is accompanied by charge transfer processes as the ion loses and gains extranuclear electrons. The study of nuclear reactions involving heavy ions and their ejection has attracted increasing attention. The discrimination of the heavy ions and the determination of their energy losses have become of great experimental importance. Fission fragments constitute a special class of heavy ions whose detection has been studied for a long time but the complexities of their detection have made the detailed analysis of the fission spectrum very difficult. Experiments made with $^{12}C^{2+}$ (9.7 MeV) accelerated by the Kyoto University cyclotron through thin layers of different metals and oxides are discussed, examining the usefulness of the Papineau semiempirical equation to the discrimination of heavy ions. (TTT)

35462 (ORAU–107, pp 148-51) TRANSISTORIZED ELECTRONIC CIRCUITS FOR THE MINIATURIZED SURGICAL PROBE. Morris, A. C. Jr.; Barclay, T. R.; Nemcek, J. V. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Transistorized electronic circuits developed for a miniaturized probe unit for detecting β and γ activity during surgery are described. The unit consists of the hand-held probe unit, preamplifier modular spectrometer system with audio pitch-varying module, and a loudspeaker box. It is suggested that the probe be used by surgeons to locate all portions of a labeled tumor. (C.O.)

35463 (ORAU–107, pp 251-4) BACKGROUND IMPROVEMENT FOR A LOW-LEVEL WHOLE-BODY COUNTER. Gibbs, W. D.; Hodges, Harold D.; Bailey, Mildred (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The method and procedures used to decrease the background count in the area of a multishielded whole-body counter are described and discussed. Residual, continuing fluctuations were

recently found to be due to pulse-like releases of radon into the shielded room from the 0.25 in-lead liner inside the 5.0 in-thick steel shield; the resin-sealed seams of the shield apparently were not impermeable to radon gas. A vacuum pump was installed to remove the gas and the background count was reduced and steady. (C.O.)

35464 (ORAU-107, pp 254-7) IMPROVEMENTS IN PROFILE-SCANNER INSTRUMENTATION. Gibbs, W. D.; Edwards, C. L.; Hodges, Harold D. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Modifications made on a profile scanner to provide discrete numerical data collection with data output in the form of perforated tape that can be read and analyzed by computer are described and discussed. In addition, provision for displaying the activity profile on a cathode-ray (tube) screen for immediate visual analysis and so that it can be recorded on Polaroid film is described. It was established that this linear scanning system provided both immediate and permanent visual display of the profile without ratemeter lag, and numerical data in discrete form. The numeric data collection made possible quantitative analyses of radioisotope concentration in any body section, the resolution being limited by collimation, table speed, and multiscale channel advance speed. (C.O.)

35465 (ORNL-TM-2592) SPACETRAN: A CODE TO CALCULATE DOSE AT DETECTORS AT VARIOUS DISTANCES FROM THE SURFACE OF A CYLINDER. Cramer, S. N.; Solomito, M. (Oak Ridge National Lab., Tenn.). June 17, 1969. 43p. Dep. CFSTI.

Program SPACETRAN is a Fortran code designed to calculate the energy-dependent total flux, or some proportional quantity, due to the radiation leakage from the surface of a right-circular cylinder at detector positions away from the surface. Two versions of the SPACETRAN code are described. One uses the surface angular fluxes calculated by the S_n code ANISN as the input; the other uses the surface angular flux described by a cosine distribution. Both versions of the code permit an arbitrary energy group structure and any number of detectors at any positions away from the surface. (auth)

35466 (ORNL-tr-2149) DETERMINATION OF THE β-RADIOACTIVITY IN WATER WITH COMMERCIAL DETECTORS (VA-Z-310, VA-Z-530, VA-T-84) FROM THE STANDPOINT OF RADIATION PROTECTION. Stange, E. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Translated for Oak Ridge National Lab., Tenn., from report SZS-1/69. 31p. Dep. CFSTI.

The technical problems associated with radiological measurements of β activity in water samples as well as the necessary corrections of the counting rate due to energy dependency are outlined (corresponding diagrams are given). The detectors VA-Z-310 (Geiger-Müller counter), VA-Z-530 (gas flow proportional counter), and VA-T-84 (scintillation counter) were examined on their applicability to radioactivity control measurements in water. For the detectors VA-Z-310 and VA-T-84 simple methods are described for the determination of the mean maximum β energy, using a special absorber and the method of discrimination, respectively. (auth)

35467 (ORNL-tr-2150) NEUTRON PROBE FOR CONNECTION TO THE VA-J-05 RADIOMETER FOR RADIATION PROTECTION MEASUREMENTS. Steuer, J.; Kiesewetter, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Translated for Oak Ridge National Lab., Tenn., from report SZS-18/68. 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 24430. (B.G.D.)

35468 (UCLA-34-P-106-33(Rev.)) CALIBRATION OF A PHOTON DETECTOR USING A MONOENERGETIC PHOTON BEAM. UCLA Internal Report (Revised). Weiss, A. J.; Nefkens, B. M. K.; Verhey, L. J. (California Univ., Los Angeles. Dept. of Physics). May 1969. Contract AT(11-1)-34. 24p. Dep. CFSTI.

Several large scintillation detectors of the "lead-plastic sandwich" type have been constructed for use as anti-counters in an experiment designed to study radiative pion capture, $\pi^- p \rightarrow \gamma n$. This process was investigated at pion kinetic energies of 200, 320, and 360 MeV for the purpose of studying the $P_{33}(1236)$ and $P_{11}(1400$, "Roper") resonances. At these energies the charge exchange reaction $\pi^- p \rightarrow \pi^0 n \rightarrow 2\ \gamma n$ exhibits a cross section which is, at some angles, several hundred times larger than that for radiative capture. The large π^0 background can be reduced by vetoing events having one of the decay gammas striking an anticounter. The efficiency of these counters depends on the photon energy, especially in the range 100 MeV and below. The photons to be discriminated against typically have energies in the range 20 to 300 MeV. The measurements were performed using the facilities of the California Institute of Technology Synchrotron Laboratory. A detailed description of the electronics and beam tune-up is included in the expectation that similar measurements will be made in the future. (auth)

35469 EFFICIENCY DETERMINATIONS FOR A Ge(Li) DETECTOR. Tokcan, G.; Cothern, C. R. (Univ. of Dayton, Ohio). Ohio J. Sci., 69: 92-100(Mar. 1969).

Two experimental methods were employed to determine the efficiency curve of a Ge(Li) γ-ray detector. In the first experiment, use was made of the known relative intensities of ^{140}La and ^{154}Eu. In the second method, 6 calibrated sources (obtained from the International Atomic Energy Agency) of γ rays of different energies were used and the efficiency curve was obtained by comparing the apparent activities with the known activities of the sources. The results from these 2 experiments were combined into a single experimental efficiency curve, which is good within an error range of 8%. The dependence of efficiency on live time was also investigated. The experimental efficiency in the energy range 150 to 1500 keV was fit by a semiempirical relation with an overall accuracy of 3%, compared to the line of best least squares fit from the experimental work. The experimental full-energy peak-efficiency curve was compared with a published semi-empirical relation given by: $\epsilon = k/c\ [1 - e^{-c\tau} + A\sigma e^{-BE}]$, where ϵ is the efficiency, and τ and σ are the photoelectric and Compton scattering absorption coefficients, respectively. The empirical constants k, A, B, and c are parameters, and E is the γ-ray energy. This relation agreed with the experimental results within an accuracy of 3%. (BBB)

35470 THE RELATIVE RESPONSE OF GMT 30/30 AB COUNTERS AND THE EFFECT OF SOME FACTORS ON RESPONSE DISSIPATION. Silar, Josef (Research Inst. of Nuclear Instruments, Brno). Jad. Energ., 15: 149-58(May 1969). (In Czech).

Relative response dissipations of several series of GMT 30/30 AB window GM-counters have been determined for ^{14}C and $^{90}Sr + ^{90}Y$ radioisotopes in close geometry. Besides the absorption of low-energy beta radiation in mica windows having specific mass from 1.35 to 1.6 mg/cm^2, the scattering in the effective window area, and in the greater extent the changes of the sensitive volume of counters caused by charging the window with positive ions, are contributing to the dissipation of relative response. The changes have the maximum in the case of reposed counters, having the effect on counting characteristics, geometrical factor, source-effective counter volume, pulse height, and on the reproducibility of results. (auth)

35471 NOMOGRAPH FOR DETERMINATION OF THE OPTIMUM MEASURING TIME OF RADIO-ACTIVE SAMPLES. Hekrdle, Jan; Vydra, Milos (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 15: 168-70(May 1969). (In Czech).

In the measuring of radio-active samples, which produce the pulses frequency comparable to or lower than the background, the longtime lasting measuring is the necessary condition of achieving satisfactorily exact results, with regard to the statistical fluctuations. The calculation method of necessary times and their minimalisation under previously selected deviation is described in the discussion and the nomograph for easy time determination is elaborated. (auth)

35472 RELIABILITY APPRECIATION OF LOW ACTIVITY MEASUREMENT USING THE TEST OF SIGNIFICANCE. Bartosek, Jiri (Inst. of Applied Geophysics, Brno). Jad. Energ., 15: 167-8(May 1969). (In Czech).

With respect to disturbing effects in radioactivity measurements, the total measuring time interval is recommended to be divided in two or more equal parts, and the significance of the differences between partial results to be tested by the reported test so that the erroneous measurement might be excluded. (auth)

35473 STUDY OF A SIMPLE INSTALLATION FOR HUMAN GAMMA SPECTROMETRY. Frossard, H.; Arnaud, G.; Andrieu, L.; Fabre, J.; Dongradi, G. (Armees-Hopital Militaire d'Instruction Percy, Clamart, France). Radioprotection, 3: 311-18(1968). (In French).

A simplified human spectrometry installation is described; the results obtained show that the sensitivity of the apparatus is only two times less high than that of a complete human spectrometry assembly, under enclosure. For the radioelements tested, it was shown that internal contaminations of the order of 1/1,000 of the maximum permissible concentration were detectable. This high sensitivity is due to the position of the detector collimated in contact with the epigastric cavity. This simple mobile device seems to give a solution to the problems posed by the systematic monitoring in γ spectrometry of workers directly connected with working under radiation. (tr-auth)

35474 SELECTIVE CONTROL OF ALPHA CONTAMINATION BY A FLAT PROPORTIONAL COUNTER OPERATING IN FREE AIR. Picco, Ch. (Univ., Toulouse). Radioprotection, 3: 319-21(1968). (In French).

A counter with large detection surface, designed to control the α radioactivity in the presence of a background of β and γ rays, was developed. It is composed of several anode wires, coplanar, regularly spaced and parallel to a plane cathode. The presence of a window in transparent metallic foil protects the detector from dusts. The passage of a weak electric current in the anodes eliminates the interfering effect of water vapor. (tr-auth)

35475 IMPROVEMENTS IN OR RELATING TO DEVICES FOR DETECTING PARTICLES. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,155,375. June 18, 1969. Priority date Sept. 24, 1965, France.

Reference is made to devices for charged particle detection comprising two superposed semiconductor detectors in a common semiconductor body, together with the appropriate circuitry. In the system described one detector measures the differential coefficient of particle energy (dE/dx) with regard to the path traversed by the particles in it, whilst the other detector measures the particle energy (E). Each detector has a rectifying junction. The first detector comprises a semiconducting epitaxial layer on a region of the second detector. The epitaxial layer may consist of a region of one conductivity type adjacent to the second detector, together with a diffused region of opposite conductivity type adjacent to the surface of the epitaxial layer remote from the second detector, the junction between the first and second regions of the epitaxial layer being the rectifying junction of the first detector. The epitaxial layer may also comprise a region of one conductivity type adjacent to the second detector and a surface barrier layer adjacent to the surface of the epitaxial layer remote from the second detector, the junction between the surface barrier layer and the epitaxial layer being the rectifying junction of the first detector. The epitaxial layer may also be of one conductivity type and the second detector of the opposite conductivity type, the junction between the second detector and the epitaxial layer being the rectifying junction of the first detector. The epitaxial layer and the second detector may be of the same semiconducting material. The circuit arrangement comprises means for applying voltages to bias the rectifying junctions in the reverse direction, so that in operation the depletion layer of the first detector extends substantially across the whole thickness of the epitaxial layer. The system is particularly suitable for identification of particles having energy between 10 and 50 MeV. (UK)

35476 RADIATION DETECTING SYSTEMS. Hyun, Kyung Ho (to English Electric Co. Ltd.). British Patent 1,154,432. June 11, 1969. Filed Jan. 6, 1967.

Reference is made to continuous radiation monitoring systems and sampling units for use in such systems; such a system may be applied as a burst cartridge detection system for a gas-cooled nuclear reactor. In the system described the sampling unit comprises a vessel containing a polarising electrode arranged to be negatively charged, so that positive ions are collected by the electrode and build-up of contamination due to decay of these ions on the inside wall of the vessel is prevented. The vessel is preferably spherical in form, and the polarising electrode part-spherical in form and concentric with the vessel. The sampling unit may include a passage for transmission of gamma radiation from inside the vessel to the measuring means, and means for circulating a continuous stream of clear gas at least over a portion of the internal surface of the vessel. The measuring means may be a scintillation counter. (UK)

35477 FAST NEUTRON MONITORING BY DETECTING PROMPT GAMMA-RAY FROM $^{1}H(n,\gamma)^{2}D$ REACTION. I. Fujishiro, Masatoshi; Furuta, Junichiro. Annu. Rep. Radiat. Center Osaka Prefect., 9: 52-4(1968).

Fundamental experiments on the detection of prompt gamma-ray for monitoring fast neutrons are presented. Merits and faults of this method are discussed in comparison with other methods. (auth)

35478 LOGARITHMIC AMPLIFIER. (to Atomic Energy of Canada Ltd.). British Patent 1,156,559. July 2, 1969. Priority date Dec. 28, 1965, United States.

A logarithmic amplifier for use with an ionization chamber is described. (B.G.D.)

35479 RADIATION SCANNING DEVICE. (to Intertech Inc.). British Patent 1,156,262. June 25, 1969. Priority date June 1, 1966, United States.

A radioisotope scanner which is comprised of a linear array of scintillation detectors, a collimator associated with each detector in order to transmit radiation emanating from different preselected focal point, a method for moving the detector array over a region to be inspected to cause each of the focal points to trace a pre-selected scanning pattern, and electronic equipment for processing and recording graphically the pulses from the scintillation detectors. (B.G.D.)

35480 NUCLEAR TRACKS IN SOLIDS. Fleischer, R. L.; Price, P. B.; Walker, R. M. Sci. Amer., 220: No. 6, 30-9(June 1969).

The mechanism of charged particle track formation in dielectric materials is described, and the chemical etching process for making the particle tracks more readily visible is discussed. Also, some of the scientific and technological applications of the phenomenon are discussed including fission track dating, cosmic ray studies, search for magnetic monopoles, search for ternary fission, use for identification of element number 104, and use for the manufacture of Nuclepore filters. (W.H.K.)

35481 SCINTILLATION PROPERTIES OF CERTAIN LUBRICATING OILS. I. Zemskova, I.; Matveevskii, R. M. Khim. Tekhnol. Topliv Masel, No. 2, 49-51(1969). (In Russian).

Peak heights of impulses from ^{60}Co γ radiation were studied as a function of concentration of additives to lubricating oils. Data are reported for various combinations of PPO, POPOP, and naphthalene in vaseline oil, and PPO, NPO, triphenylpyrazoline, naphthalene, and POPOP in silicone oil No. 5. Comparison of peak heights for various materials containing indicated scintillators in the noted number of g/l solvent gave: toluene, 4 g PPO and 0.05 g POPOP, 0.60 units; oil VM-14, 4 g PPO, 0.05 g POPOP, 100 g naphthalene, 0.58; silicone oil No. 5, 4 g PPO, 0.1 g POPOP, 100 g naphthalene, 0.55; vaseline oil (medical use), 4 g PPO, 0.05 g POPOP, 50 g naphthalene, 0.54; machine oil, 4 g PPO, 0.05 g POPOP, 50 g naphthalene, 0.40; oil AU, 4 g PPO, 0.1 g POPOP, 0.30; oil MGE-10, 3 g PPO, 0.1 g POPOP, 0.10; castor oil, 4 g PPO, 0.1 g POPOP, 0.10. Thus the scintillation efficiency of the best oils corresponds to 60% of that of a stilbene crystal. (BBB)

35482 SPURIOUS PULSES IN METHANE FILLED PROPORTIONAL COUNTERS. Campion, P. J.; Kingham, M. W. J. (National Physical Lab., Teddington, Eng.). Int. J. Appl. Radiat. Isotop., 20: 479-92(July 1969).

The time distribution of spurious pulses in methane filled proportional counters under various conditions is presented. In all cases the spectra were found to be continuous up to the positive ion transit time, at which point a weak ion-cathode effect was observed. The average mobility of the positive ions in methane was found to be 2.4 ± 0.1 cm/sec per volt/cm. Possible mechanisms for the production of spurious pulses prior to this transit time are discussed; an ion-molecule reaction is believed to be responsible for spurious pulses in the middle time range, while those produced within the first few tens of microseconds may result either from electrons becoming trapped in the dense positive ion cloud or from a two-stage process involving hydrogen radicals. An upper limit for the probability of a spurious pulse occurring when a counter was operated at the center of the plateau (for Fe-55 x-rays) was estimated as 2×10^{-5} per genuine pulse. (auth) (UK)

35483 COUNTING OF CHERENKOV RADIATION FROM ^{32}P IN NONAQUEOUS MEDIA. Johnson, M. K. (Medical Research Council, Carshalton, Eng.). Anal. Biochem., 29: 348-50(May 1969).

Counting efficiencies for phosphorus-32-produced Cherenkov radiation in various media are tabulated, and the color quenching of phosphorus-32 Cherenkov radiation in an ethanol–water mixture is presented graphically. (W.H.K.)

35484 COMPUTER-CONTROLLED MICROSCOPE FOR SCANNING FISSION TRACK PLATES. Cohn, Charles E.; Gold, Raymond; Pienias, Thaddeus W. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 68(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35485 A NEW APPROACH TO THE GAMMA-FLASH PROBLEM: GAMMA CANCELLATION MODE. Gozani, T.; Ginaven, R. O. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 68-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35486 HIGH-LEVEL GAMMA TOLERANCE OF FISSION CHAMBER AND BORON-LINED NEUTRON COUNTERS. Jackson, Charles N. Jr.; Holtink, Neil C. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 310-11(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35487 INCREASING OF RELATIVE LIGHT YIELD OF LIQUID SCINTILLATOR BY ULTRASONIC. Gratsinskii, V. G.; Tyminskii, V. G. At. Energ. (USSR), 26: 300-1(Mar. 1969). (In Russian).

An improved yield of light from a liquid scintillator was achieved using pulsed Permendur emitter as a source of ultrasonic waves. Tabulated data obtained for γ-irradiated liquid scintillators (toluene, xylol, phenylcyclohexane, vaseline oil, polyethylsiloxane liquid No. 5 (TU 2416-54) and stilbene) show that the use of an ultrasonic field increases the pulse amplitudes. Moreover, for toluene, xylol, and phenylcyclohexane the amplification is negligible (1.25 to 1.33 fold) but for polyethylsiloxane the pulse amplitude increased 3 to 4 fold. In recording α-particles from ^{233}U with ultrasonic treated liquid dioxane scintillator, the efficiency of the scintillator increased by 60%. The results obtained confirm that ultrasonic fields increase the relative yield of liquid scintillators and may be used in scintillation detectors for recording low-energy particle energy. (R.V.J.)

35488 DETERMINATION OF RADIATION DOSE TO LUNGS BY MEANS OF MEASUREMENT OF GAMMA-RADIATION FROM CHEST. Ruzer, L. S.; Urusov, S. A. At. Energ. (USSR), 26: 301-3(Mar. 1969). (In Russian).

Contribution of RaB to the γ irradiation of the chest cavity was determined and the influence of concentration of radon daughter products, inhaled from the air, on the recorded dose was estimated. A portable device for measuring the inhaled doses in working conditions is described. (R.V.J.)

35489 THERMAL NEUTRON FLUX DENSITY STANDARD. Andreev, O. L.; Yaritsyna, I. A. At. Energ. (USSR), 26: 304-5 (Mar. 1969). (In Russian).

Descriptions are given of the design and performance of a device for measuring with precision the unit of density of thermal neutron flux using an activation detector. The systematic order of error for measuring the activity was taken as 0.5% due to the sensitivity of the β counter and γ emission, and due to the effects of internal conversion. The order of error for σ_0 was 0.3%, for F_{Cd} (correction taking into account absorption of over-cadmium neutrons in a 1 mm thick cadmium screen) it was 0.2%, and for G(t) it was 0.2%. Thus total systematic error was 1.2%. So, the developed standard density for thermal neutron flux was 6890 neutr/cm^2 · sec. (R.V.J.)

35490 GAMMA-RAY LOGGING IN URANIUM PROSPECTING. Hawkins, W. K.; Gearhart, M. (Gearhart-Owen Industries Inc., Forth Worth, Tex.). pp 213-22 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Gamma-ray systems that have a wide range response are required for uranium exploration. Low-grade ore bodies with marginal economic feasibility are particularly dependent on reliable, calibrated gamma-ray logs. Wide range gamma-ray counting systems for this purpose are described, with particular emphasis on the downhole wide range gamma-gross count probe. Gamma-detector types, calibration of the system, and interpretation methods are reviewed. The "hardware" characteristics are detailed to provide an understanding of equipment capabilities and limitations. It is necessary to discriminate between the valuable uranium ore and other radioactive materials, at present of little value. Therefore gamma-spectral logs are of considerable interest but available equipment limits the use of such techniques. Equipment limitations and possible improvements, such as use of coaxial logging cables, are covered, and actual field conditions are considered. (auth)

35491 A VERSATILE FIELD INSTRUMENT FOR X-RAY FLUORESCENCE ANALYSIS. Duftschmid, K. E. (TYCO, Claremount, Calif.). pp 325-42 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

A portable x-ray fluorescence analyzer has been developed consisting essentially of an Xe/CH_4 proportional counter probe and an electronic unit with single-channel analyzer, binary scaler, digital-to-analog converter with meter-readout and an automatic gain control circuitry. The instrument utilizes the high energy resolution of proportional counters combined with the excellent long-term stability provided by automatic gain control (AGC). The radioactive source, ^{241}Am, is suitable for the excitation of fluorescence x-rays in a wide range of elements, i.e., from Cr-K (Z = 24) to Tm-K (Z = 69), and from Ba-L (Z = 56) to U-L (Z = 92). The same source is simultaneously used for the AGC operation by measuring a small fraction of the ^{241}Am gamma-radiation (59.6 keV) directly incident through a small collimator hole into the detector. The count-rate measured above a threshold at 57 keV, which is not affected by any other fluorescent or scattered radiation, is used to control the detector high voltage in order to obtain a constant energy calibration and to eliminate any drift of the detector and the electronics. Thus several fixed single-channel windows selected by a rotary switch can be set for various elements of interest. Once having been set in the laboratory no further calibration is necessary for field operation. The prototype of the instrument was originally developed and used to determine nickel coatings on steel, which necessitates a very high energy resolution of the detector. Without using filters a sufficient sensitivity could be obtained. The same probe can also be equipped with balanced filters and the electronic unit with a reversible scaler providing direct indication of the difference counting rate of the meter, without fluctuations. However, in many cases filters can be saved because of the high energy resolution of the detector. The design features of the instrument make it extremely suitable for a wide range of prospecting and mining applications. (auth)

35492 RADIOISOTOPE X-RAY FLUORESCENCE DRILL HOLE PROBE. Rhodes, J. R.; Furuta, T.; Berry, P. F. (Texas Nuclear Corp., Austin, Tex.). pp 353-63 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

A radioisotope x-ray fluorescence drill hole probe of prototype design is described. The main potential application of such an instrument is for logging uncased and preferably dry drill holes in metalliferous ore deposits; for example, to locate cut-off horizons during development mining operations. A double scintillation detector arrangement is used, with balanced filters. The geometry of the source-detector assembly pays high regard to the importance of cylindrical symmetry and utilizes a simple design and inexpensive components. Initial results have been obtained for silver and uranium in concrete standards. Preliminary field tests on a model uranium bore hole are also described. Sensitivities of 0.015 wt % Ag and 0.15 wt % U in 10 s measurement times were obtained, and further improvements by at least a factor of two are shown to be possible. (auth)

35493 FIELD EQUIPMENT FOR NEUTRON ACTIVATION ANALYSIS. Tolmie, R. W.; Thompson, C. J. (Atomic Energy of Canada Ltd., Ottawa). pp 489-505 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Neutron activation analysis offers some appealing advantages for routine geochemical analyses. Sample preparation is simple, sensitivities are very good for many elements, several of which may be analyzed simultaneously, and the technique averages the concentration in a reasonably large sample. Neutron activation analysis equipment is now available compact enough to be transported to a base camp, and is easy to operate. Such a system is described comprising an Sb : Be neutron source with a pneumatic sample transport, a pair of scintillation counters in a 4-in. thick lead shield, a Ge-(Li-drift) detector and a small computer. Applications include ore assay, rock identification, and exploration based on trace element contouring. Typical results from a variety of such applications are presented. (auth)

35494 AFTER-EFFECT OF THE HALOGEN QUENCHED G-M COUNTER. Narita, Yuichi (Univ. of Akita, Japan). Radioisotopes (Tokyo), 18: 245-51(July 1969). (In Japanese).

The characteristics of the after-effect of the halogen quenched counter studied by means of the ^{90}Sr RI chopper and the pulsated x-ray beam of the Linac are described. The experimental results show that the after-effect of the halogen quenched counter is independent of the radiation intensity. The after-effect does not increase with the intensity of a pulsated radiation beam even though the pressure of quenching gas (Br_2) is as low as 0.05 Torr, and only the short-time after-effect which depends on the number of main discharge pulses was observed under a constant anode voltage. Accordingly, the halogen quenched counter maintains a steady state in the high intensity radiation if a corrective coefficient of the after-effect is given. (auth)

35495 STABLE 1 pF CHARGE INJECTION CAPACITOR FOR NUCLEAR PULSE PRFAMPLIFIERS. Brenner, Raul (Argonne National Lab., Ill.). Rev. Sci. Instrum., 40: 1011-13(Aug. 1969).

Servostabilizers used with Ge(Li) γ-ray spectrometers are fre-

quently referenced to pulser peaks obtained by injecting the output of a stable pulse generator into a charge sensitive preamplifier via a small capacitor. A 1 pF charge injection capacitor has been developed that meets the requirements of high resolution spectrometers. The three terminal air capacitor has a coaxial structure with electrodes made of Kovar. It has a temperature coefficient ranging from –1 to +6 ppm/°C and a long term stability of ±20 ppm, i.e., less than ±0.1 channel out of 4000. It adds only 1 pF of stray capacitance to ground at the preamplifier input and the noise added with 3 kV across it is negligible. (auth)

35496 SIMPLE FLOW PROPORTIONAL DETECTOR FOR SOFT X RAYS. Baun, William L. (Air Force Materials Lab., Wright-Patterson Air Force Base, Ohio). Rev. Sci. Instrum., 40: 1101-2(Aug. 1969).

A simple small (5 cm long) flow proportional detector for soft x rays is described. The detector is constructed from 3.175 cm hexagonal aluminum bar stock. The detector window is cut in one face of the bar and the ultrathin window seals on that face. O-ring construction is used to allow easy placement of the 0.00254 cm tungsten wire. The operation of the detector at subatmospheric pressure in a high vacuum chamber is described. Vacuum and gas connections to the detector and to a manometer are shown which allow operation at 100–150 Torr with reference to the chamber pressure. Operating voltage using P-10 gas and counting monochromatic Al K_α at 8.34 Å is 950 V at 150 Torr and 1750 V at 760 Torr. (auth)

35497 SINGLE DETECTOR METHOD FOR HIGH RESOLUTION INTERNAL CONVERSION COEFFICIENT MEASUREMENTS. Avignone III, F. T.; Knox, H. H. (Univ. of South Carolina, Columbia). Rev. Sci. Instrum., 40: 1046-9(Aug. 1969).

A method for measuring internal conversion coefficients, in which γ rays and conversion electrons are detected in the same Si(Li) detector, was developed. The energy spread for both γ rays and electrons is 5 to 7 keV. The detector is mounted on a cold finger in a vacuum chamber with the source. The chamber has an externally controlled aluminum electron absorber between source and detector for γ-ray measurements, which can be rotated away for electron measurements. This apparatus was calibrated using nine well known conversion coefficients with electron energies from 62 to 973 keV. The α_K of the 355 keV transition of ^{133}Cs and the α_K and α_L of the 482 keV transition of ^{181}Ta were measured by this method. The values are (0.020 ± 0.001), (0.0234 ± 0.0010), and (0.0054 ± 0.0003), respectively. (auth)

35498 USE OF A TWO CHANNELTRON COINCIDENCE IN A NEW LINE OF RESEARCH IN ATOMIC PHYSICS. Amaldi, U. Jr. (Istituto Superiore di Sanita, Rome); Egidi, A.; Marconero, R.; Pizzella, G. Rev. Sci. Instrum., 40: 1001-4(Aug. 1969).

Quasifree scattering of electrons on bound electrons gives direct information on the electronic wave functions in atoms and molecules, if the incoming energy is definitely higher than the electron binding energy. To tackle this new line of research the two outcoming electrons, whose energies are typically in the 0.1–10 keV range, have to be detected with good energy resolution and short resolving time. These technical problems have been solved by using two hemispherical electrostatic analyzers ($\Delta E/E \simeq \pm 0.4\%$) and two Channeltrons as detectors; the measured fwhm resolving time is 4.3 nsec. Energy spectra are presented, in which the peak due to K electrons in carbon is well resolved. (auth)

35499 ELIMINATION OF COLOR QUENCH IN LIQUID SCINTILLATION COUNTING OF FECAL EXTRACTS BY OZONIZATION. Krabisch, L.; Borgstroem, B. (Univ. of Lund, Sweden). Scand. J. Gastroenterol., 3: 458-60(1968).

A method is described whereby ozonization is used for decolorization of the neutral steroid fraction of fecal lipids to eliminate color quench in liquid scintillation counting. Ozonization of the samples was performed in solution of 10 ml of chloroform in 100 ml round-bottom flasks. The ozone was bubbled in a gentle stream until decolorization was complete. The usual time for decolorization was no longer than 5 min. After ozonization, the chloroform was evaporated and the lipid fraction dried in vacuo. Ozone gave almost complete decolorization and quench elimination. No loss of radioactivity was found when ozonization was used with fecal fat containing cholesterol-4-^{14}C or sitosterol-22-23-^{3}H or their intestinal degradation products. (BBB)

35500 SCINTILLATION CAMERA. Ronai, P. M.; Baker, R. J.; McCusker, J.; Shearer, J.; Lander, H. (Inst. of Medical and Veterinary Science, Adelaide). At. Energy Aust., 12: No. 2, 2-9(Apr. 1969).

A brief description of the design and operation of gamma and positron scintillation cameras is presented; and clinical applications, including function studies and radiodiagnosis of the brain, liver and spleen, kidneys, and bones, are surveyed. (W.H.K.)

35501 GAMMA-RAY POLARIZATION MEASUREMENTS WITH A SINGLE Ge(Li) DETECTOR. Ewan, G. T.; Andersson, G. I.; Bartholomew, G. A.; Litherland, A. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Lett., 29B: 352-4 (June 9, 1969).

The linear polarization sensitivity of a single rectangular Ge(Li) detector, $4 \times 2.5 \times 0.35$ cm^3 was measured. It was used to study the polarization of the prominent γ-rays emitted in the ^{100}Mo(α,2n)^{102}Ru reaction. (auth)

35502 RECENT INSTRUMENTATION ADVANCES IN URANIUM PROSPECTING. Stewart, J. R. S. Afr. Mining Eng. J., 80: 196-200(Jan. 24, 1969).

Significant new reserves of U will have to be discovered and brought into production by the mid-1970's. There will be an increasing need for more effective means of locating U ore bodies in more difficult geological environments. Several techniques offering considerable promise are γ spectrometry, radon surveys, and trace element surveys. Principles of detection of γ rays by G-M and scintillation counters are described. Spectrometers for airborne and ground prospecting operations have been limited to those of scintillation counter type. Even where an airborne γ spectrometer records an anomaly predominantly due to Th, the occurrence should be followed upon the ground because there is a greater tendency for surface leaching of U minerals compared with Th minerals and radiation from Th has a greater power of penetration through rocks, soil and air than radiation from U. Equipment for field measurement of small concentrations of Rn in soil and water has only recently become available; prototype instruments have been in use for some years in France, the U.K. and elsewhere. Radon surveys are now used only as a subsidiary method to careful scintillometer surveys. Considerable work has been carried out in recent years on analytical methods for determining ppB concentrations of trace elements in soil and rock. Several different methods for detection of Hg have been published. The Hg anomaly around a metalliferous deposit tends to be more dispersed than anomalies recorded for base metals. In Australia, the Hg technique would appear particularly suitable for use in searching for U ore bodies of the South Alligator River type. (BBB)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 35021, 35416, 37138, 37169, 37191, and 37193.

35503 (KFK-887) TWO-PARAMETER γ-γ COINCIDENCE ANALYSIS WITH A Ge(Li)–NaI(Tl) SPECTROMETER AT THE KARLSRUHE FR-2 REACTOR. Fanger, U. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Jan. 1969. 13p. (In German). Dep.

The coincidence combination of Ge(Li) diodes with NaI(Tl) detectors represents an efficient spectrometer especially in the γ energy range from 100 keV to 3 MeV. The coupling of the apparatus to the Karlsruhe computer system MIDAS makes possible two-parameter measurements with full channel resolution. The advantages resulting lie in the simultaneous detection of several coincidences and in the optimum positioning of the coincidence window in spectra with good counting statistics at the end of a measurement. (tr-auth)

35504 (KURRI-TR-10, pp 52-65) EXPERIMENTAL APPARATUS FOR (n,γ) REACTIONS. Shikazono, Naomoto (Japan Atomic Energy Research Inst., Tokyo). (In Japanese).

The characteristics of the commonly used experimental setups for studying (n,γ) reactions are compared. The thermal neutrons exciting from a reactor comprise a high-flux source that is used for studying (n,γ) reactions. As a result of reactions, this source creates a very strong γ field; this high-intensity field allows to sacrifice the detecting efficiency for increased resolution. Detectors most frequently used for γ detection include the crystal diffraction spectrometer, Compton spectrometer, and pair spectrometer. The characteristics of each type of spectrometer are listed, indicating the representative instrumentation and experimental technique. A port placed in the reactor shield, intercepting tangentially the core periphery, is used in the experiments; this arrangement minimizes the background. An example is presented to illustrate efficiency and resolution of the spectrometer for a specific geometry, employed at the Japan Atomic Energy Research Institute. (TTT)

35505 IMPROVEMENT IN AIRBORNE GAMMA-RADIATION DATA ANALYSES FOR ANOMALOUS RADIATION BY REMOVAL OF ENVIRONMENTAL AND PEDOLOGIC RADIATION CHANGES.

Foote, R. S. (Texas Instruments Inc. Dallas). pp 187-96 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Analysis of airborne gamma-radiation spectral data gathered from an array of 11½-in.-dia by 4-in.-thick NaI(Tl) detectors provides isoradiation maps of the average surface concentrations of uranium (^{214}Bi), thorium (^{208}Tl) and potassium (^{40}K) only if aircraft and atmospheric radiations are properly measured and removed. The atmospheric radiation consists of ambient, diurnal and surface pedologic components. Airborne measurement of the average radiation along a flight line indicates ^{208}Tl and ^{40}K surface intensities to be consistently measured to ±2%. Airborne measurement of ^{214}Bi intensities at 400-ft surface altitude indicates that as much as 70% of the data originates in the atmosphere as a result of the decay of atmospheric radon concentrations. These atmospheric ^{214}Bi intensities are being measured and removed from the data. Much data have been accumulated indicating the specific correlation between the average intensities of radiation from the decay of the natural radionuclides within pedologic environments. Thus, digital data gathered from a magnetic tape multichannel analysis system can be reduced by computer operation to give isoradiation maps that indicate regions of anomalous radiation where the effects of surface pedologic changes are minimized or removed. This analysis separates desired anomalies from those created by surface pedologic changes. (auth)

35506 AIRBORNE GAMMA RAY SPECTROMETRY. Tipper, D. B. (Hunting Geology and Geophysics, Ltd., Sydney). Aust. Mining, 61: 42-4(Apr. 15, 1969).

A system for airborne radiometric prospecting for minerals with a gamma spectrometer is described. The four channels used are 0.2–2.9 MeV (total count), 1.35–1.55 MeV (potassium peak at 1.46), 1.65–1.85 MeV (uranium series bismuth-214 peak at 1.76) and 2.4–2.9 MeV (thorium series thallium-208 peak at 2.62). Operational precautions and some aspects of interpretation of results are outlined. (Australia)

35507 HIGH-EFFICIENCY GAMMA-RAY SPECTROMETER USING TWO SEPARATE COAXIAL Ge(Li) DETECTORS. Wahlgren, M. A.; Strauss, M. G.; Hines, J. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 67(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35508 THE APPLICATION OF ANTICOINCIDENCE-SHIELDED Ge(Li) SPECTROMETERS TO RADIOCHEMICAL PROBLEMS. Cooper, J. A.; Perkins, R. W.; Rancitelli, L. A.; Wogman, N. A. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 65-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35509 OPTIMIZING PULSE-HEIGHT RISETIME ANALYSIS. Greenberger, S.; Cuttler, J. M.; Shalev, S. (Israel Inst. of Tech., Haifa). Trans. Amer. Nucl. Soc., 12: 64-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35510 HIGH-RESOLUTION FAST-NEUTRON SPECTROMETER. Cuttler, J. M.; Shalev, S.; Dagan, Y. (Israel Inst. of Tech., Haifa). Trans. Amer. Nucl. Soc., 12: 63(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35511 TOTAL AND SPECTROMETRIC GAMMA-RAY SURVEYS FROM HELICOPTERS AND VEHICLES. Adams, J. A. S. (Rice Univ., Houston, Tex.). pp 147-61 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

A single-channel gamma-ray spectrometer has been built and tested in surveys from the air and vehicles. Using a 5 in. × 5 in. sodium iodide (thallium-activated) scintillation crystal, thorium, uranium and potassium anomalies can be detected in the upper 10 to 25 cm of soil or rock. Thorium and uranium anomalies are of interest as pathfinder elements to locate and define placer deposits, changes in lithology, changes in sedimentary facies, and differences in soil type, e.g., tropical iron and aluminum ores. The 750 km of modern beach in the state of Texas were completely surveyed by helicopter in five flying days. Anomalies containing as little as 6 ppM thorium and 3 ppM uranium as determined by analysis of ground samples were readily detected against a background of beach sand containing 1 to 2 ppM thorium and 0.3 to 0.6 ppM uranium at ground speeds of 105 km/h (60 knots) and elevations of 17 ± 1 m. At such altitudes and ground speeds, a complete coverage of the surface can be obtained in the Texas uranium districts at costs well under $175/km^2. The relative contributions of thorium or uranium to a particular total gamma-ray anomaly have been successfully measured by gamma-spectrometry from the air at the above altitudes and ground speeds. The instrumentation has application for the direct exploration for potassium, thorium and uranium, and for the pathfinder applications, e.g., bedded phosphates that contain over 10 ppM uranium and placer deposits that contain twice background thorium or uranium. Placers are prime exploration targets because they often contain multiple mineral values, and modern placers along beaches or rivers provide convenient ground control for navigation purposes. In evaluating placers, a combination of gamma-ray and aeromagnetic techniques is advantageous because many placer deposits contain enough ilmenite and magnetite to give a detectable aeromagnetic anomaly under the conditions of the gamma-ray survey. Furthermore, the aeromagnetic anomaly will arise from minerals at much greater depths than is the case with the gamma-ray anomaly. (auth)

35512 AIRBORNE GAMMA-RAY SPECTROMETER EXPERIMENTS OVER THE CANADIAN SHIELD. Darnley, A. G. (Geological Survey of Canada, Ottawa); Bristow, Q.; Donhoffer, D. K. pp 163-86 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The Geological Survey of Canada and Atomic Energy of Canada Ltd. have produced a high sensitivity spectrometer for radiometric mapping of the Canadian Shield. During 1967 experiments were undertaken in the Bancroft and Elliot Lake areas of Ontario to determine the system parameters. Ground control was provided by measurements with field gamma-ray spectrometers on a 200-ft grid over 3 square miles. An experimental spectrometer employed three 5 × 5 in. (12.5 × 12.5 cm) dia NaI(Tl) detectors, in order to record the full gamma-spectrum in real-time on magnetic tape. To provide the highest possible count-rates per unit distance at varying heights the spectrometer was flown in a helicopter at 25 mph (40 kmph). A study of the spectra obtained shows that the optimum spectral window widths for measuring the relative abundance of potassium, uranium and thorium are: potassium, ^{40}K 1.35–1.58 MeV; uranium, ^{214}Bi 1.65–1.88 MeV; thorium, ^{208}Tl 2.42–2.62 MeV. The recorded data were subsequently processed through a PDP-9 computer to provide corrections for dead-time, Compton scattering and deviations from constant terrain clearance. Based on this work a much more sensitive airborne system was constructed in 1968 and installed in a twin-engined STOL aircraft. The system employs twelve 9 × 4 in. (23 × 10 cm) NaI(Tl) crystals. This detector volume provides a 10% (1 standard deviation) precision in corrected accumulated count in any of the three spectral windows when the aircraft measures radiation over an elapsed distance of 350 ft at a ground speed of 120 mph and 400 ft terrain clearance. The airborne system includes Doppler navigation, radar altimeter, and TV tracking camera equipment. (auth)

35513 HIGH SENSITIVITY ALPHA-SPECTROMETER FOR THE ANALYSIS OF SAMPLES WITH LOW SPECIFIC ACTIVITY. Biro, Janos; Feher, Istvan; Lendvay, Janos; Toth, Adam. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 17: 119-28(1969). (In Hungarian).

An ionization chamber was developed for the investigation and spectrometry of natural alpha emitters with specific activity of picocurie per gram order. The flow-type chamber operates with a mixture of argon–methane gas. The relative half-width of the spectral line at 3.98 MeV of ^{232}Th is 6.9%. For a counting period of 8 hours the minimum detectable activity is 0.35 picocurie per gram in the range of energies from 3.5 to 6 MeV. The equipment is applicable for the alpha spectrometry of natural waters, minerals and biological samples. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 36878 and 37041.

35514 (JINR-P1-4490) TAKING ACCOUNT OF PARTICLES LEAVING A DETECTOR DUE TO SCATTERING. Burduli, A. V.; Dzhalaganiya, D. D.; Kostanashvili, N. I.; Lebedevich, G. I.; Nabichvrishvili, D. S.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 11p. (In Russian). Dep.

The parameters characterizing the scattering of π^+-mesons with the energies up to 80 MeV in photoemulsion were investigated experimentally. The method of determination of correc-

tions to the particles leaving the detecting system due to scattering has been considered. This method can be applied also in the case of large ionization losses. (auth)

35515 ULTRASONIC HELIUM BUBBLE CHAMBER. Ultrasonics, 7: 93(Apr. 1969).

Use of an ultrasonic standing wave system to provide the expansion required in a bubble chamber is described. The main advantage is that a high repetition rate is possible. A small helium chamber in which ultrasonic expansion can be tested in particle beams is illustrated. The chamber is essentially a horizontal cryostat of 3 cylindrical glass vessels. In the inner vessel are 2 piezoelectric transducers, with crystal diameters of 7 cm and a separation of 5 cm. The inner vessel is surrounded by an evacuated heat shield and an independent cooling circuit pumps liquid through the evaporation chambers in the inner vessel. The carefully tuned chamber operating at 110 KHz has produced bubbles along tracks of minimum ionizing pions and protons in a temperature range 3.4 to 3.65°K. Bubbles have been observed to grow to visible size (100 μ) within 600 μsec and the bubble intensity along the tracks is typically 8 to 10 bubbles/cm. (BBB)

35516 GENERATION OF MECHANICAL VIBRATIONS BY PENETRATING PARTICLES. Beron, B. L.; Hofstadter, R. (Stanford Univ., Calif.). Phys. Rev. Lett., 23: 184-6(July 28, 1969).

Mechanical oscillations of lead–zirconate–titanate piezoelectric disks were observed when penetrating high-energy (1.0-BeV) beams of electrons impinge on the disks. Radial and compressional modes of vibration were observed in the frequency range 40–158 kHz. Possible applications of this observation to particle detection at very high energies are discussed. The observed phenomenon also has a possible connection with measurements of gravitational waves. (auth)

Radiation Dosimeters

Refer also to abstract 35735.

35517 (BNL–13766) APPLICATION OF CHEMICAL REACTOR DESIGN PRINCIPLES TO PROBLEMS OF DOSIMETRY IN FLOW SYSTEMS. Hill, F. B.; Fallon, P. T.; Muller, A. C.; Rothbart, M. A. (Brookhaven National Lab., Upton, N. Y.). [1969]. 32p. (CONF-690805–1; SM–123/44). Dep. CFSTI.

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

Problems arising in chemical dosimetry in flow systems were analyzed in terms of chemical reactor design principles and were studied experimentally. Calculations were made of fraction conversion-dose relations in radiation chemical reactors with nonuniform distributions of dose rate and residence time in which the reactant was the aerated Fricke dosimeter solution. Reactors considered had annular reaction volumes with axial line sources and included the continuous tubular reactor and the continuous stirred tank reactor. The calculations showed that at large conversions the rate of radial mixing in the single-pass tubular reactor and degree of segregation in the stirred tank reactor are important factors relating conversion to absorbed dose. Initial rates, however, are unaffected by mixing or degree of segregation, and, therefore, can in principle be used to determine absorbed dose. The determination may also be made from data from the tubular reactor when operated with almost total recycle. Several aspects of the flow dosimetry problem were explored experimentally. Conversion was measured vs. flow rate of the Fricke solution in two tubular reactors and one stirred tank reactor, all annular reactors with axial line sources. The two tubular reactors were nominally identical in dimensions except for radial thickness of reaction volume. A 20-Ci line source of $^{90}Sr-^{90}Y$ beta particles was used in these reactors. The dose determined from the initial slope of the experimental fraction conversion-mean residence time relation obtained in single-pass laminar flow agreed very closely with the dose obtained with recycle for both reactors. In the experiments with recycle, conversion was insensitive to recycle flow rate for recycle rates large compared with the through-flow rate. The stirred tank reactor measurements were made in a stirred 5-liter vessel with an axial strip source of ^{60}Co gamma radiation. Source strength and stirring speed were parameters. Little or no evidence of segregation was found. The dose determination could, therefore, be based on a complete micromixing model. The absence of segregation was consistent with the long mean residence times used compared with measured dispersion times. (auth)

35518 (JINR–P16–4480) SLOW NEUTRON DETECTOR WITH THE POLYETHYLENE SPHERE MODERATOR USED IN NEUTRON DOSIMETRY. Aleinikov, V. E.; Arkhipov, V. A.; Komochkov, M. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 20p. (In Russian). Dep.

A device for measurement of a dose equivalent, absorbed dose, and neutron flux is described. The neutron detector uses the reaction $^{10}B(n,\alpha)^{7}Li$, which is recorded as scintillations of α-particles in ZnS(Ag). (auth)

35519 (ORAU–107, pp 37-9) TECHNIQUES FOR ENHANCED TLD RELIABILITY. Beck, W. L. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Improved methods for calibration and annealing of lithium fluoride thermoluminescent dosimetry (TLD) systems are described and discussed. New dosimeters were first annealed for 1 hr at 400°C. After this, they were given a sensitizing exposure of 100 R and reannealed by a 3-step process that is described; the dosimeters were then calibrated. (C.O.)

35520 ELECTROCHEMICAL DOSIMETERS OF HIGH-INTENSITY GAMMA RADIATION. Kalmykov, L. Z.; Vasil'ev, A. G.; Vail, E. I. At. Energ. (USSR), 26: 386-8(Apr. 1969). (In Russian).

The possibility of using aqueous solutions of sodium nitrate, uranyl sulfate and sulfuric acid for electrochemical dose rate measurements in remote locations is investigated. The radiolysis products of these solutions (nitrate, quadrivalent uranium, and hydrogen peroxide) are oxidized to the starting products at potentials of 1.23, 1.05, and 1.14 volts, respectively. Thus on passage of an electric current, the reduced form is converted back to the oxidized form. The observed current is the sum of the oxidation currents of all the radiolysis products. If a suitable rate of oxidation of hydrolysis products is created, then at a constant dose rate a stationary state characterizing the equality of the rate of formation of hydrolysis products to the electrochemical requirements is established after a certain time. A three-electrode cell was used in the experiments with solutions irradiated with cobalt-60 gamma rays. A linear dependence between current strength and dose was found at dose rates up to 3000 r/sec. After absorption of 10^{8} r, the current strength was still 92% of its initial value. (TTT)

35521 APPARATUS FOR MEASURING THE EXTENT TO WHICH DOSIMETERS HAVE BEEN IRRADIATED. (to Societe de Realisations Mecaniques et Electroniques CEHESS). British Patent 1,156,179. June 25, 1969. Priority date Dec. 13, 1965, France.

An apparatus is described for dose readout from photoluminescent dosimeters. The apparatus consists of an ultraviolet radiation source to stimulate the dosimeter and a photomultiplier for measuring the intensity of the light produced which is proportional to the dose. (B.G.D.)

35522 PROCESS FOR PRODUCTION OF A POLYCRYSTALLINE LITHIUM FLUORIDE STORAGE PHOSPHORESCENT SUBSTANCE. Frank, Manfred; Edelmann, Bernd-Udo (to VEB Vakutronik Wissenschaftlicher Industriebetrieb Dresden). British Patent 1,154,484. June 11, 1969. Filed June 22, 1966.

Reference is made to a further development of the process of British Patent 1,126,777 for the production of LiF of which the glow maximum of thermoluminescence occurs at 200°C for dosimetric purposes. An activator combination is added to an aqueous lithium salt solution and fluoride precipitation is carried out. The activator combination may be Mg–Ti, Mg–Eu, Mg–Ca, Mg–Ti–Ca, or Mg–Eu–Ca, in small concentrations. The LiF is washed to remove acid, dried and annealed. Annealing may be carried out in platinum or quartz vessels for 10 to 120 min. at 560 to 650°C. The LiF may be after-treated either by high dosage irradiation (50 to 250 kR) and subsequent heating at 280 to 320°C, or by heating after every measurement at 380 to 450°C. Energy dependence may be corrected by mixing in boron oxide or nitride. Sensitivity for thermal neutrons may be increased by introduction of ^{6}Li enriched compounds into the preparation process. (UK)

35523 ON THE BADGE FILM DOSIMETRY USING X-RAY ABSORPTION METHOD. Kanazawa, Tamotsu; Okamoto, Sinichi; Furuta, Junichiro. Annu. Rep. Radiat. Center Osaka Prefect., 9: 55-7(1968).

The badge film dosimetry is, usually, performed by the optical method. A method of Sb-Kα x-ray absorption in a film was studied. It is realized by this method that the large doses not measurable by the optical method are measurable. The non-uniformity of silver or silver-bromide on films and its effect on the dosimetry were examined. (auth)

35524 PRELIMINARY EXPERIMENT ON DOSIMETRY OF HIGH ENERGY X-RAYS WITH THE SOLID STATE TRACK DETECTOR. Matsuda, Yatsuka; Mamuro, Tetsuo. Annu. Rep. Radiat. Center Osaka Prefect., 9: 18-21(1968).

A preliminary experiment has been made in order to confirm

the possibility to make dosimetry of high energy x-rays with the solid-state track detector. It was found that the intensity of high energy x-rays produced by a linear accelerator can be measured even near the target with a mica plate placed in contact with an electroplated uranium film. (auth)

35525 EFFECTS OF ULTRAVIOLET LIGHT ON THERMOLUMINESCENCE OF LiF. Corinaldesi, A. (Univ., Bologna); Cecchetti, E.; Petralia, S. Radiobiol. Radioter. Fis. Med., 23: 383-92(Nov.-Dec. 1968). (In Italian).

A study of uv effects on LiF thermoluminescent dosimeters is presented. In phosphors irradiated with x radiation but not yet read, there is an exponential decay in thermoluminescence as a function of the exposure time. Concerning the phosphors which are already read, the uv light causes a transfer of holes giving rise to a second thermoluminescence signal whose value goes through a maximum in case of a certain exposure to uv light. Such a maximum depends upon the quality of x radiation and is about 10% of the initial signal. This action can be used as a method to re-read the x doses absorbed in the phosphor. (auth)

35526 THERMOLUMINESCENT, INDIVIDUAL DOSIMETERS. Kudelin, K. M.; Bulgakov, V. B.; Popov, G. N. At. Energ. (USSR), 26: 385-6(Apr. 1969). (In Russian).

LiF phosphor is the most suitable of the thermoluminescent phosphors for use in dosimeters because of its good sensitivity. Single crystals of lithium fluoride were grown in air to a length of 50 to 80 mm and a diameter of 25 to 35 mm. Selected single crystals were cut into bars 8 × 8 mm, and then into plates 0.8 to 1 mm thick. After cutting the crystals were annealed 1 to 2 hours at a temperature of 600 to 700°C with subsequent cooling for a period of 3 to 5 hours. The low-temperature emission peak at 140°C exceeded the high-temperature emission peak at 180°C by a factor of 3 to 4. The second thermopeak was completely absent in some of the samples. The crystals were wrapped in a chrome-plated copper backing 0.2 mm thick to allow uniform heating of the whole crystal. The residual thermoluminescence after light emission (heating to 210 to 230°C) did not exceed 2 to 5 mr on irradiating with a dose up to 100 R. With long storage (a month or more) no light accumulation was noted except for natural background radioactivity. The sensitivity of the dosimeters did not change noticeably after 50 to 100 irradiations by x rays or gamma rays to a dose of 1 R with subsequent emission of light each time. The decrease in light yield at about 20°C was 7 to 12% after a day, and about 20% after one week. Reproducibility of the reading was 2 to 4%, and the measurement time was less than 3 min. (TTT)

35527 HEAT LOSS COMPENSATED CALORIMETER. Domen, S. D. (National Bureau of Standards, Washington, D. C.). Nature (London), 222: 1061(June 14, 1969).

The design of the calorimeter described is intended essentially to eliminate systematic errors caused by temperature gradients. The body has a core which is completely surrounded by a thermally isolated jacket of equal heat capacity. Thermistors embedded in both body and jacket, to indicate temperatures, form the opposite arms of a Wheatstone bridge that is initially balanced when the core and jacket temperatures are at equilibrium. The jacket is surrounded by a shield that either remains at constant temperature, or follows the rising temperature of the jacket, depending on the mode of operation. Heat lost from the core but retained in the jacket contributes to the output of the Wheatstone bridge just as if retained in the core, and compensation for heat lost from the core is nearly independent of temperature gradients produced in the core during energy absorption. The relatively small jacket leakage correction can be assumed to be made with good accuracy where the shield is maintained at constant temperature. For operation in the adiabatic mode the temperature of the shield can be made to follow the rising temperature of the jacket more readily and accurately than with an unjacketed core. Operation to measure absorbed dose in a radiation field is described. (UK)

35528 NEUTRON PERSONNEL MONITORING: CORRECTION FACTORS AND A SUGGESTED DEVICE FOR MEASURING INTERMEDIATE ENERGY NEUTRONS. Nagarajan, P. S.; Krishnan, D. (Bhabha Atomic Research Centre, Trombay, India). Health Phys., 17: 323-9(Aug. 1969).

Monte Carlo estimates of neutron backscatter from an infinite slab of standard man composition were arrived at, in the incident neutron energy range of 0.025 eV–10 MeV, for normal and isotropic incidence. The information obtained includes: (i) the total and thermal components; (ii) the spectrum; and (iii) the angular distribution of the backscatter component. As the thermal neutron component of the backscatter would be recorded by thermal neutron personnel monitoring devices, the thermal backscatter response of such devices for various incident energies was estimated, and appropriate correction factors recommended. This correction is negligible at higher incident neutron energies (of the order of 0.5% in the range 1–10 MeV), whereas it increases to 50–60% in cases where thermal and intermediate energy neutrons are incident. The secondary gamma dose resulting from (n, γ) capture in tissue was also considered. This dose was estimated at the surface of an infinite slab of standard man composition, and was found to agree with reported experimental values. This gamma dose would be recorded in gamma radiation personnel monitoring devices as a superfluous dose. The relevant correction factor was therefore estimated. This correction is negligible in the neutron energy range 1–10 MeV and reaches a steady value of about 10% in the neutron energy range of 10 keV to thermal. A composite personnel monitoring device for both thermal and intermediate energy neutrons, is suggested. (auth) (UK)

35529 RADIATION DOSIMETRY BY QUININE SULPHATE. Rytila, A.; Spring, E. (University Central Hospital, Helsinki). Health Phys., 17: 336-8(Aug. 1969).

A method for low-level chemical dosimetry is provided by the destruction of fluorescent molecules in aqueous solution as a result of ionizing radiation. One material which might be used is quinine sulfate, as it can be measured in an aqueous solution at a concentration as low as 10^{-11} mole/l by the employment of a fluorometer. A G-value of 2.3 was determined for the initial quinine sulfate concentration 10^{-3} g/l. (auth) (UK)

35530 CHEMICAL DOSIMETRY: TRIPHENYLMETHANE DYE INTERMEDIATES. Wankerl, M. (Univ. of Arizona, Tucson); Wacks, M.; Harrah, L. A. Trans. Amer. Nucl. Soc., 12: 60-1(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35531 CELLULOSE ACETATE BUTYRATE DOSIMETER. Rizzo, F. X. (Brookhaven National Lab., Upton, N. Y.); Krishmamurthy, K. Trans. Amer. Nucl. Soc., 12: 61-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35532 RED ACRYLIC DOSIMETRY SYSTEM. Brown, W. R. (Atomic Energy of Canada Ltd., Ottawa). Trans. Amer. Nucl. Soc., 12: 62(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35533 PREDICTION OF WALL EFFECT FOR ^{3}He SPECTROMETERS. Cuttler, J. M.; Fishelson, Z.; Shalev, S. (Israel Inst. of Tech., Haifa). Trans. Amer. Nucl. Soc., 12: 63-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Radiometric Instruments

35534 (RISO-M-896) MONTE CARLO STUDY OF NEUTRONS IN SOIL FOR SURFACE MOISTURE GAUGES. Kirkegaard, Peter (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr. 1969. 54p. Dep.

A Monte Carlo model has been developed describing the neutron slowing-down and diffusion in soil in connection with a neutron moisture gauge of the surface type. (auth)

35535 NUCLEONIC SOIL DENSITY AND MOISTURE GAUGES. Cameron, J. F. (Nuclear Enterprises Ltd., Edinburgh). pp 81-104 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

After a brief summary of the applications and merits of portable nucleonic gages in measuring the moisture content and density of soils, the theory and practice of the techniques involved are reviewed. Particular attention is paid to the proper methods to be employed in calibration and use of these instruments, and due emphasis is given to the practical and theoretical limitations of the techniques. (auth)

35536 MINIATURIZED PULSED NEUTRON SOURCE FOR A BOREHOLE GENERATOR. Vasin, V. S.; Galkina, E. B.; Grishaev, A. I. Geofiz. App., No. 33, 126-9(1967). (In Russian).

A miniaturized borehole neutron generator is described, with photographs and diagrams. (Geophys. Abstr.)

35537 GALLONS AND GAMMAS. Steinbrenner, Fred. Lockheed Ga. Quart., 6: No. 2, 24-8(June 1969).

The development of a radiometric fuel gage for aircraft, using krypton-85 sources and a Geiger–Mueller detector array, is described. Advantages of the radiometric gage over capacitance gaging systems are cited including reliability, savings in aircraft

weight, elimination of probe fouling, and reduced susceptibility to corrosion and fatigue. (W.H.K.)

35538 PORTABLE BERYLLIUM PROSPECTING INSTRUMENT WITH LARGE SENSITIVE AREA. Loevborg, L. Danish Atomic Energy Research Commission, Risoe, Denmark); Kunzendorf, H.; Hansen, J. pp 55-63 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 196

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

The instrument described was designed on the basis of the photoneutron method of determining beryllium in rock surfaces and developed with a view to prospecting beryllium minerals in the Ilímaussaq intrusion, south Greenland. These minerals occur mainly in hydrothermal veins which are from 1 mm to about 2 m wide. Of the ten beryllium minerals found until now, chkalovite (12% BeO) is the most common. The distinctive feature of the prospecting instrument is a comparatively large effective measuring area (~500 cm^2). Since the instrument is intended for use in a difficult terrain without roads, it has been necessary to limit its weight and size as much as possible. The instrument consists of a detector unit and a control unit. The detector unit has the dimensions 46 × 21 × 10 cm, weighs 20 kg, and contains a 30-cm long gamma-activation device, a biological radiation shield, and two 30-cm long ^{3}He-filled neutron proportional detectors embedded in paraffin wax. The gamma-activation device consists of 31 identical ^{124}Sb-sources placed in a steel tube with spacings decreasing towards the ends of the tube and with a total activity of 20 mCi. During transport of the instrument the gamma-activation device is placed at the center of the radiation shield, when the maximum dose-rate on the surface of the detector unit is 200 mR/h. When the instrument is in use, the activation device is turned to a position just above the bottom of the detector unit. The sensitivity per cm^2 of the bottom surface to a 5-cm thick layer of beryllium is 20% of its value at the center of the bottom surface along a curve which is roughly an ellipse with axes 34 and 18 cm. The total sensitivity of the instrument is about 35 counts/min per % BeO per mCi ^{124}Sb, and the background count-rate is 12 to 20 counts/min. The corresponding theoretical detection limit for a single measurement of 8-min duration is 35 to 50 ppM BeO. (auth)

35539 USE OF THEORETICAL MODELS FOR NEUTRON MOISTURE GAUGE CALIBRATION AND DESIGN. Oelgaard, P. L. (Danish Atomic Energy Commission Research Establishment, Risoe, Denmark). pp 65-79 of Nuclear Techniques and Mineral Resources. Vienna, International Atomic Energy Agency, 1969.

From Symposium on the Use of Nuclear Techniques in the Prospecting and Development of Mineral Resources, Buenos Aires, Argentina. See STI/PUB-198; CONF-681117.

Neutron moisture gages during recent years have proved to be a valuable tool for measuring moisture content in soils and similar media. However, the response of these gages is affected not only by the moisture content, but also by the chemical composition and density of the dry media. To perform accurate measurements the effect of the density and composition of the dry media must be taken into account. This can be done by use of the theoretical models which have been developed for these gages, in particular for sub-surface probes. The basic physics behind the neutron moisture gages is outlined, and the various existing theoretical models are briefly reviewed. The effect of variation in dry soil density is discussed, and it is emphasized that it is not possible to perform good measurements by use of just one calibration curve corresponding to one dry soil density, even though this procedure is often used. Fortunately theoretical models allow the determination of calibration curves for various dry soil densities, provided the soil composition is known. The effect of the chemical composition of the dry media is also considered. A theoretical method is discussed by use of which it is possible to obtain calibration curves corresponding to any dry medium density without detailed knowledge of the composition of the medium. This method demands, however, that a set of calibration measurements exists for the probe and soil under consideration. Through examples it is also demonstrated how the theoretical models can be used in connection with probe design. These considerations pertain first of all to sub-surface moisture gages. A short discussion of theoretical models for surface moisture gages is, however, also given, and the need for a reasonably simple, yet reliable model for surface gages is stressed. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 34971, 35455, 35463, 35798, 36000, and 37061.

35540 (AECL-3187) AN ON-LINE COMPUTER APPLIED TO A CLIMATOLOGY STATION. McGovern, T. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Jan. 1969. 21p. (CONF-681207-4). Dep. CFSTI. CAN $1.00.

From Digital Equipment Computer Users Society Conference, San Francisco, Calif.

The existing meteorological system at Whiteshell Nuclear Research Establishment included several instruments for measuring wind speed, wind direction, temperature and radiation. The data were recorded on continuous and multipoint strip chart recorders. The computer system was designed to digitize and reduce the recorded data to enable a more efficient and accurate analysis of the data to be made. This would ultimately provide the meteorologist with the facility and the time for a more in-depth study of diffusion climatology in the Whiteshell area. The approach is applicable to other meteorological systems. (auth)

35541 (AERE-R-5921) DIFFERENTIAL THERMOCOUPLE AND ITS ERRORS IN A REACTOR ENVIRONMENT. Smith, A. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1969. 11p. Dep. CFSTI. UK 2s. 6d.

A differential thermocouple is described and its errors compared with those of a backed-off pair of thermocouples in a reactor environment, using experimental data on the change of Seebeck coefficient with temperature and time. Data on changes of Seebeck coefficient with integrated flux enabled an estimate of the performance of a differential thermocouple constructed of three materials to be made. An experimental program to obtain further data for the more accurate prediction of its performance is outlined. (auth) (UK)

35542 (BNWL-1042) ADJUSTABLE SLIT ASSEMBLY. Stoffels, J. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 5p. Dep. CFSTI.

A slit assembly providing independently adjustable slit-width and position is described. Adjustment is made by bellows seals and commercial micrometer heads. The entire assembly is mounted on a $2^{3}/_{4}$ in. OD high-vacuum flange, with stainless steel being the only material exposed to vacuum. The design is applicable to any type of spectrometer requiring beam definition. Complete blueprints are included. (auth)

35543 (CEA-R-3802) TIME FLUCTUATIONS IN THE RESPONSE OF PHOTOMULTIPLIER TUBES DARIO 56 AVP, XP 1021, XP 1210. Breuze, Gerard; Sawine, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1969. 40p. (In French). Dep.

The intrinsic time resolving power of 3 photomultiplier tubes, Dario 56 AVP, XP 1021, XP 1210, were studied at various excitation levels produced by a source of short light pulses. They show, in agreement with present theories, that there exists an optimal resolving power for a certain trigger threshold, and they check the law governing the variations of this resolving power with the average number of photo-electrons emitted by light pulse, up to the limiting case of a single photo-electron. The results obtained show the progress which has been made by the constructor between the 56 AVP and the XP 1210 models: for 100 photo-electrons per pulse, for example, the times of resolution are 260×10^{-12} secs and 75×10^{-12} secs, respectively; whereas the rise time for the anode pulses decreases from 2.3 to 1.2×10^{-9} secs. The intermediate tube XP 1021 has also a particularly good performance with respect to the 56 AVP, which it resembles very much both in its price and appearance. The difficulties encountered in measuring with accuracy the time characteristics of PM as fast as the XP 1210 and the limitation imposed by the light source are discussed. (auth)

35544 (CNAEM-48) PROGRESS REPORT, JULY 1, 1967-DECEMBER 31, 1967. (Cekmece Nuclear Research Center, Istanbul (Turkey)). Mar. 1968. 28p. (In Turkish). Dep.

The research carried on in chemistry, diffractometry, spectrometry, theoretical physics, plasma physics, radiobiology, nuclear engineering, and electronics is briefly summarized. The operation of the TR-1 research reactor and health physics services are reviewed. Technical information services are also briefly reviewed. (C.E.S.)

35545 (JINR-P13-4453) GAS-FILLED MASS-SEPARATOR FOR INVESTIGATION OF THE HEAVY ION REACTION PRODUCTS. Bacho, I.; Bogdanov, D. D.; Darotsi, Sh.; Karnaukhov, V. A.; Petrov, L. A.; Ter-Akop'yan, G. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 27p. (In Russian). Dep.

A gas-filled mass separator for the investigation of short-lived products of nuclear reactions induced by heavy ions is described. For ^{103}Ag recoils in the case of helium filling, the resolution is

obtained to be ≈3% (on Hρ); 15 to 20% of recoils escaping the target reach the focal plane. The separator parameters with air filling are investigated as well. The Hρ values for recoils are investigated in the mass range from 84 to 149. Anomalous decrease of the equilibrium charge in the transition to the rare-earth elements is observed; for dysprosium it is equal to 15%. Apparently, the filling of the inner 4f-electron shell leads to decrease of the electron cross section. (auth)

35546 (LA-4103) DIFFERENTIAL THERMAL ANALYSIS APPARATUS FOR OBSERVATION OF REFRACTORY PLUTONIUM COMPOUNDS. Reavis, J. G.; Buchen, J. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Jan. 20, 1969. Contract W-7405-eng-36. 6p. Dep. CFSTI.

An apparatus was constructed and used to measure melting points and temperatures of crystallographic transition of refractory compounds of Pu and other intense alpha emitters potentially useful as reactor fuels. The thermal analysis apparatus responds to light energy radiated by the sample and furnace, and temperatures are measured by optical pyrometry. The specialized nature of the equipment necessitated an intensive calibration study over the range 1000 to 2440°C. (auth)

35547 (LA-4115-TR) LOW-RESISTANCE VOLTAGE DIVIDER FOR PHOTOMULTIPLIERS. Jung, H.; Bruellmann, M. Translated for Los Alamos Scientific Lab., N. Mex., from Nucl. Instrum. Methods, 65: 178(1968). 6p. Dep. CFSTI.

The stability of a photomultiplier at high counting rates required the use of a low-resistance voltage divider for the last few dynodes. This has been achieved by means of a transistor circuit that stabilizes the potentials of the last three dynodes by comparison with the corresponding potential of an unloaded resistance voltage divider. The dynode voltages can thus be varied over a wide range. The temperature dependence of the elements has been practically eliminated by means of a symmetrical circuit design. (auth)

35548 (LA-4117) DESIGN AND OPERATION OF THE LOS ALAMOS AUTOMATIC COMPARATOR FOR MEASUREMENT OF SPECTRA. Steinhaus, David W.; Engleman, Rolf Jr.; Fisher, Kay J. (Los Alamos Scientific Lab., N. Mex.). Dec. 1968. Contract W-7405-eng-36. 67p. Dep. CFSTI.

Supersedes LA-3100.

This automatic comparator uses a digital computer to do the complete job of finding and measuring each spectral line in an absorption or emission spectrum. The spectral information is transcribed into a list of readings taken at small equal intervals along the spectrum. These readings are transmission values from spectrum plates, or intensity values recorded directly from a scanning spectrometer. The computer output consists of the positron, wave number, log intensity, and shape of each line found. The results are similar to those obtained by a skilled operator using a photoelectric comparator, but are more consistent and obtained much more rapidly. This report supersedes LA-3100 which originally described the automatic comparator. Changes to both the apparatus and the computer program improve reliability and reduce the number of errors. (auth)

35549 (ORNL-tr-2147) AUTOMATIC TRACING OF CONTOUR CURVES USING AN A(I,J) MATRIX OF STATISTICAL QUANTITIES. Kamoun, R.; Faucon, A.; Gluzman, P. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Nucl. Instrum. Methods, 58: 45-56(1968). 21p. Dep. CFSTI.

The use of a multiparameter system for the purpose of observing gamma-charged particle correlations has led to the representation of experimental results by contour curves. Starting with a smoothing operation this processing was found adequate for an A(I,J) matrix, where A is the number of nuclear events corresponding to two correlated parameters (e.g., energies), as in particle-gamma correlation experiments. (W.H.K.)

35550 (RFP-925) RECIPROCAL MULTIPLICATION METER. Sheets, Warren R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 9, 1969. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

A reciprocal multiplication (1/M) meter has been developed and successfully tested at the Rocky Flats Plant, Nuclear Safety Laboratory. The instrument presents continuous readings of reciprocal multiplication while an experiment is in progress. Normally the reciprocal multiplication is obtained by taking counts of the neutron-leakage field intermittently during a test. Use of the instrument provides a continuous account of reciprocal multiplication, while reactivity is being added. (auth)

35551 (UCRL-18926) PHASE DETECTOR. Robinson, H. P. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 3p. Dep. CFSTI.

A simple phase detector is described which can be used to compare the relative phase of a signal and a train of pulses, the two not necessarily having the same repetition period. (auth)

35552 (UCRL-71665) WIDEBAND ATTENUATION AND PHASE MEASUREMENTS ON HIGH QUALITY COAXIAL CABLES. Evans, A. M.; Rhoads, R. L. (California Univ., Livermore. Lawrence Radiation Lab.). June 12, 1969. 13p. (CONF-690806-1). Dep. CFSTI.

From Western Electronic Show and Convention, San Francisco, Calif.

Discrepancies in the skin-effect model for interpreting data acquired via coaxial transmission lines are pointed out, and results of tests of various coaxial cables are presented. Cables tested include those with corrugated conductors, those with smooth cylindrical conductors supported with a helically wound dielectric strip, and one with a braided outer conductor and solid dielectric attenuation and time delay data are presented. An output prediction using laboratory waveshapes is presented and shown to compare to a measured input–output pair. (W.H.K.)

35553 (UNC-5232) A CONTINUOUS ELECTROCHEMICAL METER FOR MEASUREMENT OF HYDROGEN IN SODIUM. Progress Report, July 1, 1968–September 30, 1968. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Oct. 31, 1968. Contract AT(30-1)-3908. 26p. Dep. CFSTI.

Ten experimental electrochemical hydrogen sensors were tested in hydrogen–argon mixtures at several hydrogen levels ranging down to concentrations equivalent to below 1 ppM hydrogen in sodium. In general, sensors operating with gas reference electrodes and electrolytes consisting of ionic hydrides dissolved in LiCl–KCl eutectic responded to hydrogen changes in accordance with a hydride ion transport concentration cell model. The departure of voltage response from theoretical, however, increased as the hydrogen level decreased. The testing of sensors in a sodium loop was initiated. (auth)

35554 PRIMENENIE AVTOMATICHESKIKH USTROISTV V FIZICHESKOM EKSPERIMENTE. (The Application of Automatic Apparatus in Physical Experiment). Sokolov, M. P. Moscow, Atomizdat, 1969. 471p.

Automation of contemporary physical experiments and construction of automatic apparatus and recording centers are examined. Particular attention is given to nuclear electronics equipment including counters, timers, recording devices, digital printing machines, choppers, and magnetophones. Various data handling systems are described in detail. (495 references.) (auth)

35555 A KIT SYSTEM OF NUCLEAR MEASURING INSTRUMENTS OF THE BIOPHYSICAL INSTITUTE. Boucek, Jiri (Karlovy Univ., Prague). Jad. Energ., 15: 202-4(June 1969). (In Czech).

Information on the BFU transistorized modular instrumentation used in designing measuring sets in radioisotope diagnostics is presented. The main parameters of the units used, and examples of measuring sets are reported. (auth)

35556 SB-IGFET, II: AN ION IMPLANTED IGFET USING SCHOTTKY BARRIERS. Lepselter, M. P.; MacRae, A. U.; MacDonald, R. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 812-13 (May 1969).

Insulated-gate field-effect transistors have been made which combine the advantages inherent to Schottky barrier source and drain electrodes with ion implantation. This device has a self-aligned gate structure achieved by using the thick gate electrode as a mask during the ion implantation process. (auth)

35557 COOLING FOR EXHALATION MEASUREMENTS USING PELTIER'S METHOD. Herrmann, D. B.; Hamel, P. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Z. Med. Labortech., 9: 30-4(1968). (In German).

An apparatus fitted with a cooling cascade of thermocouples is described which is employed to concentrate ^{222}Rn from the exhaled air of persons with radium incorporation (^{226}Ra). An outline of the principles for determining the Ra content of the body by exhalation measurements is given. The construction and mode of operation of the cooling apparatus are discussed and essential characteristics of the apparatus are presented characterizing its working efficiency. (auth)

35558 CONVERSION OF A THERAPY X-RAY UNIT FOR INSECT IRRADIATIONS. Ware, G. W.; Irwin, C. K. (Univ. of Arizona, Tucson). J. Econ. Entomol., 62: 721-5(June 1969).

Design modifications for a General Electric Maximar 400 therapy x-ray unit are presented to allow its use for irradiation of insects. The unit is oil cooled and was designed to operate

continuously at 400 peak kV anode voltage and 5 mA. Operated at this level, the tube delivered a radiation exposure of approximately 14 R/min at a target-to-skin distance of 70 cm. (W.H.K.)

35559 DIGITAL STORAGE OF RADIOISOTOPE INDICATOR CONCENTRATION DATA ON FM ANALOG MAGNETIC TAPE. Malindzak, George S, Jr.; Swonger, Kenneth D. (Wake Forest Univ., Winston-Salem, N. C.). Comput. Biomed. Res., 1: 615-22(June 1968).

A practical and functional design for the storage of radioisotope indicator concentration data in digital form on FM analog magnetic tape is described. The converter utilizes the 12-bit parallel binary output of a digital ratemeter which was converted into a 4-line 1-2-4-8 binary-coded-decimal (BCD) pattern suitable for recording on any multichannel FM instrumentation tape recording. The output levels were set at ±1 V in order to be compatible with external line logic levels. The computer processed the digital ratemeter data on-line and off-line in experiments dealing with tube models and anesthetized animals in which the mean transit time, appearance time, flow, and volume were computed. The stability and reproducibility of the experimental digital data stored in this form far exceeds that of equivalent analog data. This design extends the accuracy of blood-flow and cardiac-output determinations using radioisotope indicator-dilution techniques. (BBB)

35560 DEVELOPMENTS PERTAINING TO ELECTROCHEMICAL OXYGEN METERS. Berkey, E.; Cleary, J. G. (Westinghouse Research Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 125(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35561 UNDER-SODIUM SIGNAL TRANSMITTER. Brion, J.; De Donder, M.; Van Minnenbruggen, R.; Buegman, R. (Societe Belge pour Industrie Nucleaire S.A., Brussels). Trans. Amer. Nucl. Soc., 12: 181(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35562 USE OF CHEMICAL TEMPERATURE INDICATORS IN HIGH-LEVEL RADIATION FIELDS. Rada, G.; Groening, H.; Parker, W. (Istituto Venezolano de Investigaciones Cientificas, Caracas). Trans. Amer. Nucl. Soc., 12: 309(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35563 COMPUTATION OF TEMPERATURE SENSOR RESPONSE CHARACTERISTICS USING ANALYSIS OF TRANSIENT TEMPERATURE INFORMATION. Leventis, A. A. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 309-10(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35564 AUTOMATIC RANGING PICOAMMETER FOR INDICATING REACTOR POWER LEVEL DEVIATION. Tonder, J. A.; Bollinger, R. K. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 310(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35565 A 1000-HOUR, 2300°C THERMOCOUPLE TEST. Kuhlman, W.; Baxter, W. (General Electric Co., NSP, Cincinnati). Trans. Amer. Nucl. Soc., 12: 319-21(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35566 SENSITIVE FAST-RESPONSE GAS-IMPURITY MEASUREMENT INSTRUMENT. Billeter, T. R.; Schemmel, R. R.; Brown, D. P. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 313(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35567 AUTOMATIC TESTING OF ANALOG-DIGITAL CONVERTERS. Cohn, Charles E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 313-14(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35568 IN-PILE STRAIN-GAUGE RESPONSE. Grillo, P.; Testa, G. (Centre for Nuclear Studies, Rome). Trans. Amer. Nucl. Soc., 12: 318-19(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35569 PHASE-PLANE METHOD OF EXPONENTIAL WAVEFORM MEASUREMENT. Huen, Tony (Univ. of California, Livermore). Rev. Sci. Instrum., 40: 1067-9(Aug. 1969).

In physical measurements of exponentially decaying pulses, two questions naturally arise: (1) Is the waveform really just a simple exponential? (2) And if so, what is the time constant? It is shown how both of these questions can be answered easily by using a phase–plane plot rather than by the conventional time–function display. (auth)

35570 SURFACE IONIZATION SOURCE FOR ION IMPLANTATION. Jamba, Douglas M. (Hughes Research Labs., Malibu, Calif.). Rev. Sci. Instrum., 40: 1072-4(Aug. 1969).

A surface ionization source was designed and developed to produce useful ion beams of elements with ionization potentials up to about 6 eV by using iridium (work function 5.27 eV) as the ionizing surface. Sources were operated successfully producing stable ion beams of aluminum, gallium, indium, and thallium with current densities up to 10 $\mu A/cm^2$. Neutral atoms are shielded from the beam as it leaves the source by a special design geometry. The construction, developmental details, and operating parameters of the source are described. (auth)

35571 TIME VARIANT FILTERS FOR GENERATING BIPOLAR PULSES WITH SIGNAL-TO-NOISE RATIOS OF UNIPOLAR PULSES IN NUCLEAR PULSE AMPLIFIERS. Blalock, T. V.; Nowlin, C. H. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum., 40: 1093-1100(Aug. 1969).

A time variant filter employing a simple gating technique was developed to produce bipolar pulses with signal-to-noise (S/N) ratios as good as those of unipolar pulses. The gated bipolar pulse discussed herein has an S/N ratio of a unipolar pulse shaped like the first lobe of the bipolar pulse. For the special case of symmetrical bipolar pulse shaping, the improvement in S/N ratio over the single measurement of the bipolar signal produced by conventional time invariant filters is 41.4%, and the improvement over the time invariant peak-to-peak measurement is 22.5%. The S/N ratio of the symmetric bipolar triangular pulse discussed is within 7.5% of the S/N ratio of the theoretically optimum unipolar pulse, but the system must be direct coupled from the radiation detector to the linear gate if count rate dependent peak shifts are to be avoided. (auth)

35572 SAMPLER FOR ISOTOPE INDICATOR-DILUTION STUDIES. Kirk, Bryan W.; Raber, Monte B. (Winnipeg General Hospital, Can.). J. Appl. Physiol., 26: 504-6(Apr. 1969).

The use of multiple radioisotope indicator-dilution curves in the study of the intravascular and extravascular compartments is illustrated by reference to representative indicator-dilution curves obtained by sampling from the root of the aorta after injection of ^{51}Cr-labeled red cells, ^{125}I-labeled albumin, and tritiated water into the pulmonary artery of the dog to determine the lung extravascular water volume. The volume of distribution of cells, albumin, and water can be calculated from the flow derived from each curve area and the mean transit time of the indicator. When flow is rapid and mean transit time is short, small errors in the timing of samples can lead to gross under- or overestimations of volume. A newly designed automatic blood sampler is described which combines simplicity of operation with a reduction of the errors due to uncertainty of the timing of the midpoint of injection and sampling intervals. The circuitry of the unijunction oscillator timer and driver is described. The apparatus has proven reliable in over a year's use. (BBB)

Radiation Effects on Instruments and Instrument Components

Refer also to abstracts 35486, 35525, and 36787.

35573 (SC-DC-69-1673) ANALYSIS OF IONIZING RADIATION EFFECTS IN FOUR-LAYER SEMICONDUCTOR DEVICES. Gwyn, C. W. (Sandia Labs., Albuquerque, N. Mex.). [1969]. 29p. (CONF-690704-3). Dep. CFSTI.

From Conference on Nuclear and Space Radiation Effects, University Park, Pa.

The switching of a four-layer semiconductor device in an ionizing radiation environment is calculated by solving the charge transport equations to determine the motion of the electron and hole distributions and the changes in the electric field distribution throughout a one-dimensional device as a function of time. A discussion of the characteristic device turn-on as a function of the radiation exposure and external circuit and device parameters is presented. In addition to showing the detailed calculated device behavior, the theoretical and experimental results are compared. (auth)

35574 (SC-DC-69-1678) IMPURITY EFFECTS ON TRANSISTOR CURRENT GAIN AND RADIATION TOLERANCE AT LOW TEMPERATURES. Sander, H. H.; Gwyn, C. W.; Gregory, B. L. (Sandia Labs., Albuquerque, N. Mex.). [1969]. 21p. (CONF-690704-4). Dep. CFSTI.

From Conference on Nuclear and Space Radiation Effects, University Park, Pa.

The current gain of a typical bi-polar transistor drops rapidly with decreasing temperature below room temperature, falling to near zero at approximately 100°K. However, quite different behavior is observed in NPN silicon transistors where gallium is employed as the base dopant. In these devices the gain drops in the usual manner as the temperature is decreased from 300°K to approximately 135°K. Below 135°K the gain increases with decreasing temperature, reaching a peak at approximately 76°K. Current gains as high as 50 at 76°K have been observed in these devices. Qualitatively, this behavior of the transistor gain at low temperature can be explained in terms of the change in emitter injection efficiency with temperature as a result of the different rates of carrier freeze-out in the base and emitter regions. Of even greater interest in the gallium doped devices is a significantly increased tolerance to neutron irradiation at the "gain peak" temperature versus that observed in these devices at room temperature. This behavior may be explained in terms of the decrease in the recombination in the emitter space charge region at low temperatures. (auth)

35575 14-MeV NEUTRON IONIZATION FOR PREDICTION OF TRANSISTOR RESPONSE. McGrath, E. J. (TRW Systems Group, Redondo Beach, Calif.). Trans. Amer. Nucl. Soc., 12: 60(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35576 THE PERFORMANCE OF IMPATT DIODES UNDER THE INFLUENCE OF GAMMA RADIATION. Anderson, Wayne A. (State Univ. of New York, Buffalo). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 852-3(May 1969).

IMPATT diodes have been tested under the influence of 1.85×10^6 R/h gamma radiation from a 1.5-MeV Van de Graaff generator. No measurable change in performance has been observed during or after irradiation. A 100 to 300-fold increase in bias current was measured in the preavalanche region of operation. (auth)

35577 IRRADIATION EFFECTS ON INTEGRATED CIRCUITS. I. Tsumori, Kunihiko; Okabe, Shigeru; Nakamura, Shigeki. Annu. Rep. Radiat. Center Osaka Prefect., 9: 30-3(1968).

Irradiation effects on an integrated circuit (IC) have been investigated using 5-MeV electrons from a linac. The tested IC, DTL R-S flip-flop, showed a drift of trigger threshold voltage and deformation of output pulses. After an irradiation of 1.4×10^{15} e/cm^2, the life of the IC is terminated. (auth)

35578 ANALYSIS OF TRANSISTOR I_{CBO} EXCESS CURRENTS BY GAMMA IRRADIATION. Bartholomew, C. Y. (Bell Telephone Labs., Inc., Allentown, Pa.). IEEE (Inst. Elec. Electron. Eng.), Trans. Electron Devices, ED-16: 153-4(Jan. 1969).

Excess I_{CBO} currents on Si planar transistors can be due to surface inversion layers over either the base or collector regions of the wafer. For n-p-n transistors, a collector inversion layer would be associated with a negative charge in the protective oxide over the Si chip. On the other hand, a base inversion would be associated with a positive oxide charge. Gamma irradiation produces net positive charge in the oxide of planar transistors. Thus, treatment of excess I_{CBO} devices with γ radiation should tend to recover collector channels and further degrade base channels. Such behavior is actually observed, as illustrated by experiments in which 3 groups of devices were exposed to 0.3-Mrad ^{60}Co irradiation. The γ-ray recovery method provides a rapid nondestructive, unambiguous means of determining whether excess I_{CBO} currents are associated with surface inversion layers over the base or the collector. The method can be used in conjunction with other techniques, such as photoscanning and low-frequency junction capacitance measurements, to verify the location of the inversion layer. (BBB)

35579 HARDNESS PENALTIES FOR SHIELDING TRADEOFF STUDIES. van Lint, V. A. J. (Gulf General Atomics, San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 366-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 35022, 35238, and 35392.

Basic Processes

Refer also to abstracts 35052, 35462, 35500, 35572, 35601, 35787, 35791, and 35881.

35580 (AE-345) APPLICATION OF THE MICROWAVE DISCHARGE MODIFICATION OF THE WILZBACH TECHNIQUE FOR THE TRITIUM LABELLING OF SOME ORGANICS OF BIOLOGICAL INTEREST. Gosztonyi, T. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Jan. 1969. 11p. Dep.

The modification of the Wilzbach technique using microwave discharge is routinely used in the Studsvik Isotopes Laboratory for rapid tritium labellings. The labelling of dihydrostreptomycine, tetracycline, and antipyrine are described in some detail. (Sweden)

35581 (COO-1377-10) PROGRESS REPORT, JANUARY 1968-APRIL 1969. [Key, Joe L.] (Purdue Univ., Lafayette, Ind.). May 1969. Contract AT(11-1)-1377. 9p. Dep. CFSTI.

Earlier observations that the cytoplasmic ribosomal RNA's (of M.Wt. 1.3 and 0.7 million) of higher plants arise by the selective cleavage of larger precursor molecules were confirmed. Isotope labeling techniques confirmed that rapidly labeled RNA is heterogeneous in size as determined by gel electrophoresis. In samples taken from cells labeled for 5 min there appeared to be a peak of incorporation into an RNA species of M.Wt. about 2.8 million, that became quite distinct after about 10 to 15 min of labeling. Between 10 to 20 min, radioactivity appeared in a species of RNA of M.Wt. about 2.2 million and by 20 to 25 min activity appeared in a 1.4 million component that was just larger than the 1.3 million heavy ribosomal RNA. Activity first appeared in the light ribosomal (0.7 million M.Wt. component) at about 20 to 25 min after administration of label and apparently prior to measurable incorporation into the 1.3 million rRNA component that occurred after some 25 to 35 min of labeling. (auth)

35582 (ORAU-107, pp 99-102) AUTORADIOGRAPHIC STUDIES OF THE ABNORMAL CHROMOSOME IN HUMAN MALIGNANCIES. Goh, Kong-oo; Joiner, Eugene (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Terminal autoradiographic labeling techniques were used to study the mechanism by which the abnormal chromosome in human malignancies is produced. The different labeling patterns of the abnormal chromosome that were observed are illustrated in the text. Findings suggested that this abnormal chromosome probably evolved from different normal chromosomes; possible evolutionary mechanisms are discussed. (C.O.)

35583 (ORAU-107, pp 245-8) ANTIMONY PENTOXIDE FOR SODIUM REMOVAL IN NEUTRON ACTIVATED BRAIN. Bird, E. D.; Emery, J. F.; Lupica, S. B.; Lyon, W. S. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The content of copper and manganese in the various nuclei of the brain of phenothiazine-treated Macaca mulatta was determined. Activation analysis and a radiochemical separation process using antimony pentoxide to remove sodium-24 from activated brain samples were used. The monkeys were given phenothiazine for varying times at gradually increasing amounts until 60 mg/day was reached. The average copper and manganese contents ($\mu g/g$) of the putamen, caudate and globus pallidus of the basal ganglia were 32.4 ± 5.4 and 2.05 ± 0.24, 32.7 ± 3.7 and 2.05 ± 0.19, and 25.2 ± 7.5 and 2.05 ± 0.28, respectively. In the controls, the Mn content of the putamen, caudate, and globus pallidus was 1.88 ± 0.31, 1.81 ± 0.08, and 2.09 ± 0.23, respectively; Cu content was not measured in control animals. Although the Mn content of the basal ganglia in animals treated for 1 Mo increased significantly, the results for one year did not show a significant increase. The use of the Sb_2O_5 technique provided a rapid and clean method for removal of Na before Cu and Mn were simultaneously measured. (C.O.)

35584 POST-PARTUM RELEASE OF LUTEINIZING HORMONE (LH) IN THE RAT AS DETERMINED BY RADIOIMMUNOASSAY. Rebar, Robert W.; Nakane, Paul K.; Midgley, A. Rees Jr. (Univ. of Michigan, Ann Arbor). Endocrinology, 84: 1352-8 (June 1969).

To determine the time, extent, and duration of the release of luteinizing hormone (LH), concentrations of LH were determined by radioimmunoassay in extracts of anterior pituitary glands and in sera drawn several times during the day from pregnant and post-partum rats. In the pregnant rat, no peaks in concentrations of LH in serum were found in 85 samples collected. Elevated concentrations of LH were seen as early as 2 hr after delivery with the greatest percentage occurring between 7 and 10 hr after delivery. These elevated concentrations occurred as early as 7 a.m. on the day of delivery and as late as 3 in the morning of the day following delivery. Sequential samples from individual rats showed that the onset of the rise in serum LH occurred between $3\frac{1}{2}$ and 11 hr after delivery. The release of LH was rapid, with at least a 15-fold rise in concentration (and perhaps as much as a 60-fold increase) occurring in as little as 2 hr in some cases. The initial fall in serum LH concentrations was likewise rapid. The period of major release appeared to last 4 to 6 hr, although release at a reduced rate apparently continued for several additional hours. The concentrations of LH in extracts of pituitary glands decreased significantly during the first 10 hr after delivery, continued to fall between 10 and 18 hr after delivery, and eventually fell to a concentration only $\frac{1}{3}$ that of predelivery levels. (auth)

35585 RESPONSE OF THE ADULT RAT TO ORCHIDECTOMY AND OVARIECTOMY AS DETERMINED BY LH RADIOIMMUNOASSAY. Gay, Vernon L.; Midgley, A. Rees Jr. (Univ. of Michigan, Ann Arbor). Endocrinology, 84: 1359-64 (June 1969).

Male and female rats, castrated as adults, were bled repeatedly by cardiac puncture or exsanguinated via the abdominal aorta. Within 8 hr (but not at 1, 2, 3, or 5 hr) after orchidectomy, serum LH concentrations, as measured by radioimmunoassay, were significantly ($p < 0.01$) and consistently increased, and within 24 hr the serum LH concentrations were as much as 50 times greater than those observed in intact male controls. Although the average serum LH concentration increased about 2-fold between the 2nd and 61st days following orchidectomy, subsequent increments never approached the rate of increase observed during the first day. By contrast, ovariectomy resulted in a gradual increase in serum LH concentrations; levels comparable to those seen 24 hr after orchidectomy were not observed until nearly a week after ovariectomy. When compared with female rats, male rats responded to castration with a more rapid increase in serum LH and with higher mean serum LH concentrations. Although the average serum LH concentrations increased with time after castration in both sexes, individual rats demonstrated no consistent pattern and numerous instances of declining serum LH levels were observed. Sequential (hourly) bleedings of individual rats on the 35th day after orchidectomy indicated that serum LH levels were not stable, but varied by as much as 80% over a 1 hr interval. In male rats the disappearance rate of LH (following hypophysectomy) did not appear to change during the first month after orchidectomy. Hypophyseal LH concentration and total content were increased by the third week following orchidectomy and the total LH content increased progressively between the 3rd and 8th weeks of the experiment. It is concluded that a major change in the release rate of LH occurs within 1 or 2 days after orchidectomy but develops more slowly following ovariectomy. In castrated rats of both sexes, serum LH concentrations did not bear any consistent relationship to levels observed earlier in the same animal—either on a day-to-day or an hr-to-hr basis. (auth)

35586 A NOTE ON THE NUCLEAR PHENOMENA RECORDED IN BIOLOGICAL MATERIAL. Wszolek, B.; Kukiel, E.; Konarski, J. (Technical Univ., Poznan, Poland). Acta Phys. Pol., 35: 859 (May 1969).

Results on the dependence of the number of recorded traces from neutrons, protons, and deuterons emitted by quickly proliferating cells on the time elapsed since the cessation of life processes in the cell are reported. (B.G.D.)

35587 ELEVATION OF PLASMA LH CONCENTRATIONS INDUCED BY LH-RELEASING FACTOR AS MEASURED BY RADIOIMMUNOASSAY IN THE SHEEP. Amoss, Max S. Jr.; Guillemin, Roger (Baylor Univ., Houston, Tex.). Endocrinology, 84: 1517-20 (June 1969).

With the use of a solid phase radioimmunoassay in which ovine luteinizing hormone (LH) can be detected in a concentration of 0.1 ng LH/ml, no immunochemical cross-reaction to a purified preparation of ovine LH-releasing factor (LRF) was observed at levels 1×10^3 times greater than the minimum detectable concentration of LH. Biological activity of this preparation of LRF was studied by rapid intracarotid injection (100 μg) into mature rams (55 and 60 kg body weight) and subsequent assay of phasma LH by radioimmunoassay. Concentrations of plasma LH were found to rise 3 min after injection with a peak at 5 min, after which they returned

to preinjection levels within 60 min. Intracarotid injection of purified ovine thyrotropin-releasing factor (TRF) as control produced no detectable changes of plasma LH levels measured by the radioimmunoassay. (auth)

35588 VARIABILITY OF RESPONSE IN THE BIOASSAY FOR A HYPOTHALAMIC SOMATOTROPHIN RELEASING FACTOR BASED ON RAT PITUITARY GROWTH HORMONE CONTENT. Rodger, N. Wilson; Beck, John C.; Burgus, Roger; Guillemin, Roger (McGill Univ., Montreal, Baylor Univ., Houston, Tex.). Endocrinology, 84: 1373-83(June 1969).

The bioassay based on "pituitary depletion of growth hormone content" in the rat as described by Pecile et al. (Endocrinology 77: 241, 1965) has been used to assess "growth hormone releasing activity" in crude extracts of ovine, porcine, bovine hypothalamus and purified fractions of ovine hypothalamus extracts following gel filtration on Sephadex G-25. In all experiments, control pituitary glands, were assayed for growth hormone (tibia test) at two dose levels; experimental pituitaries were assayed for growth hormone at two dose levels, or at one single dose corresponding by weight of pituitary tissue to the highest dose of the control or bracketed between the two doses of the control glands. The results of all experiments were studied by analysis of variance, followed by the multiple comparison test of Dunnett, the multiple range test of Duncan to assess significant differences between experimental and control groups and bioassays (3-point or 4-point). With these strict mathematical criteria for validity, control pituitaries gave consistent results in the bioassay; following injection of hypothalamic extracts, however, inconsistent results were obtained in the series of experiments reported here, thus precluding confirmation of the existence of a growth hormone releasing factor or its localization in a specific fraction in the effluent of the filtration on Sephadex G-25 of hypothalamic extracts with the use of this bioassay method. Radioimmunoassays for plasma and pituitary growth hormone performed on samples obtained from the same rats used in the bioassays have shown no evidence of stimulation of growth hormone secretion by any of the hypothalamic extracts, irrespective of the results that the animals might have shown in the bioassays. It is clearly stated that these data should not be construed as evidence against a neurohumoral control of growth hormone secretion. It is proposed, however, that caution should be used in drawing conclusions about evidence, characterization or significance of growth hormone releasing factor, or activity thereof using the bioassay based on measurement of pituitary growth hormone depletion in rats injected peripherally with hypothalamic extracts. (auth)

35589 STUDIES ON THE QUESTION OF IMMUNO-GLOBULIN SYNTHESIS BY HUMAN LYMPHOCYTES STIMULATED IN VITRO WITH PHYTOHEMAGGLUTININ. 3. RADIOIMMUNOLOGIC STUDIES (SEDIMENTATION ANALYSES). Thiele, H. G. Z. Immunitaetsforsch., Allergie Klin. Immunol., 136: 43-59(July 1968). (In German).

Peripheral human lymphocytes were cultured for 72 hr in TC-Medium-199 containing phytohemagglutinins and radioactive labeled aminoacids. In recent papers it was shown that lymphocytes incubated in this manner transform into blastlike cells that synthesize a considerable amount of proteins. Furthermore it was shown that the newly synthesized proteins behaved electrophoretically like gamma-globulins. Nevertheless, the experimental data (successive immunoprecipitations, measuring of radioactivity of the precipitates, autoradioimmunoelectrophoresis, and sedimentation-analysis) suppose that these proteins strictu sensori are neither immunoglobulins nor l-chains of them. (auth)

35590 ISPOL'ZOVANIE NEKOTORYKH METODOV BIOFIZIKI V SELEKTSIONNO-GENETICHESKIKH ISSLEDOVANIYAKH. (Use of Various Biophysics Methods in Selective-Genetics Studies). Lysikov, V. N. Kishinev, Izdatel'stvo Kartya Moldovenyaske, 1969. 172p.

A brief review is given of methods for use of labeled atoms. Radiobiological, electrophysiological, electron-microscopic, electron paramagnetic resonance methods and high-frequency current photography of biological objects are briefly described. (R.V.J.)

35591 NUCLEAR CONCENTRATION OF ^{3}H-ESTRADIOL IN TARGET TISSUES. DRY-MOUNT AUTORADIOGRAPHY OF VAGINA, OVIDUCT, OVARY, TESTIS, MAMMARY TUMOR, LIVER, AND ADRENAL. Stumpf, Walter E. (Univ. of Chicago). Endocrinology, 85: 31-7(July 1969).

Distribution of radioactivity in target and nontarget tissues was studied by dry-mount high resolution autoradiography at different time intervals after the injection of 6,7-^{3}H-estradiol-17β in intact immature and castrated mature rats. A nuclear concentration of ^{3}H-estradiol appears to be characteristic for all target tissues studied, that is, in epithelial cells, connective tissue cells, and muscle cells of the uterus, vagina, and oviduct; in epithelial cells of the induced mammary tumors; in acidophiles, basophiles, and chromophobes of the adenohypophysis; and in neurons concentrated in circumscribed areas of the brain. Radioactivity was also concentrated in nuclei of granulosa cells of the ovary and interstitial cells of the testes. In target cells, the silver grain concentration over nuclei appeared random and without accumulation at nucleoli. A relatively small amount of radioactivity was also found in the cytoplasm. In nontarget tissues such as liver and adrenal, no nuclear concentration of radioactivity existed. The nuclear concentration of the hormone is interpreted as being suggestive of a genomic effect not only in peripheral target tissues but also in the pituitary and brain, that is, in tissues associated with the feedback control of sexual functions. (auth)

35592 RADIOIMMUNOASSAY FOR OVINE LUTEINIZING HORMONE. SECRETION BY LUTEINIZING HORMONE DURING ESTRUS AND FOLLOWING ESTROGEN ADMINISTRATION IN THE SHEEP. Goding, J. R.; Catt, K. J.; Brown, J. M.; Kaltenbach, C. C.; Cumming, I. A.; Mole, B. J. (Univ. of Melbourne, Monash Univ., Melbourne. S. S. Cameron Labs., Victoria, Australia). Endocrinology, 85: 133-42(July 1969).

A solid-phase radioimmunoassay for ovine luteinizing hormone (LH) was developed, utilizing antibody-coated polystyrene tubes for incubation of the assay and counting of the bound tracer. Tubes were coated with equine antiserum to bovine LH (Snook), and purified ovine LH (Papkoff) was used for iodination with ^{125}I and assay standards. The procedure is simple and rapid, being completely performed in the assay tubes and giving results after a period of 48 hr. Basal levels of plasma LH were 2.9 ± 0.9 ng/ml in the cycling ewe, 1.2 ± 0.9 ng/ml in the ram, 12.6 ± 5.5 ng/ml in the oophorectomized ewe, and 1.2 ± 0.9 ng/ml in the pregnant ewe. These values obtained from jugular venous plasma are 25% higher than those measured in peripheral venous plasma. The sheep does not appear to produce a placental gonadotrophin comparable to human chorionic gonadotrophin in regard to immunological crossreaction with pituitary LH. Plasma levels of LH rose sharply 4 to 16 hr after the onset of estrus to levels of 80 to 200 ng/ml, over a total period of only 10 hr. Frequent blood sampling is necessary to delineate the estrous LH release in the sheep, and daily estimations carry a greater than 50% chance of completely missing the LH peak. Administration of estradiol-17β to anestrous sheep by intramuscular injection and intravenous infusion was regularly followed by a typical estrous peak of LH secretion. The latent period of the estrogen stimulus was approximately 9 hr, and the dose required to produce an ovulatory LH peak was 6 to 10 μg, an amount similar to that secreted by the ovary at estrus. It is likely that estrogen secretion by the ovary is a major factor in stimulating the LH release accompanying estrus in the sheep. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 35329, 35464, 35557, 35708, 35718–35720, 35779, 35792, 35794, 35801, and 35808.

35593 (CEA-tr-R-1947) DETERMINATION OF THRESHOLD FOOD CONCENTRATIONS FOR FISH LARVAE USING RADIOACTIVE CARBON. Panov, D. A.; Sorokin, Yu. I. Translated into French from Vop. Ikhtiol., 7: No. 1, 129-41(1967). 38p. (In French). Dep.

The radioactive carbon study of nutrition of aquatic animals was applied to the determination of the nourishment threshold concentration for bream larvae of the Rybinsk basin. The method used for the determination of the nourishment ingested and the quantity assimilated were described. The radiocarbon method was used for determining oxygen metabolism. The food consumption values obtained for larvae in various stages of development are tabulated. These values were very close to those obtained earlier. (J.S.R.)

35594 (ORAU-107, pp 125-9) EXPERIMENTAL ANIMAL STUDIES WITH ^{67}Ga. Hayes, R. L.; Carlton, J. E.; Byrd, B. L.; Rafter, J. J. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The one-day distribution of gallium-67 in the rat at various levels of stable gallium was investigated. The effect was far less dramatic at 24 hr than it was at 2 hr. Considerable preferential bone deposition would result from the use of 0.5 to 1.0 mg Ga/kg. Studies at time periods through 10 days showed an overall slow decrease in retention by most tissues with improvement in the relative bone deposition; the spleen, however, showed a slight increase in absolute concentration. In general, bone deposition was depressed especially where large tumors were present. The effects of infection were also investigated. (C.O.)

35595 (ORAU-107, pp 130-3) THE EFFECT OF SCANDIUM ON THE TISSUE DISTRIBUTION OF GALLIUM AND INDIUM IN

THE RAT. Hayes, R. L.; Byrd, B. L.; Rafter, J. J.; Carlton, J. E. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The effect of scandium as a pseudocarrier for gallium-67 and indium-113m in the rat was investigated. Several milligrams of Ga/kg body weight were required to achieve satisfactory differential deposition for scanning purposes. Scandium was found to be unusually effective in promoting the clearance of Ga and In from blood and soft tissues; it provided a high preferential bone deposition soon (hours) after administration. The bone localization of ^{113m}In in the rat, like that of Ga, was also enhanced by simultaneous administration of scandium, although the effect was less pronounced. Higher levels of scandium were required to achieve the distribution needed for effective scanning. (C.O.)

35596 (ORAU-107, pp 133-5) RARE EARTHS AS POSSIBLE BONE-SCANNING AGENTS. Hayes, R. L.; Byrd, B. L.; Carlton, J. E. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The effects of various chelating agents on the clearance rate of ^{159}Dy from rat tissues were studied; nitrilotriacetic acid (NTA) was found to be the most effective. The effect of the NTA dose on the 4-hr distribution of ^{159}Dy (2 μg/kg) in the rat was then investigated and a level of ~15 mg NTA/kg body weight appeared to be optimal for differential bone deposition. Toxicity studies were not conducted. (C.O.)

35597 (ORAU-107, pp 146-8) CURRENT VALUE OF ^{131}I-TRIOLEIN FOR EVALUATION OF MALABSORPTION. Goswitz, Francis A.; Stephens, Nelson (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Purified ^{131}I-labeled triolein and the impure commercially prepared ^{125}I-labeled triolein were simultaneously administered to patients without malabsorption. Fat absorption studies were normal in these five patients; discrepancies between the purified and impure triolein fractions were found in the percentage of the dose absorbed. Data are presented in tabular form. From a clinical interpretation the values were all normal. (C.O.)

35598 (ORAU-107, pp 223-7) L-THYROXINE TURNOVER BY WHOLE-BODY COUNTING IN PATIENTS RECEIVING EXOGENOUS THYROID HORMONE. Bird, E. D.; Gibbs, W. D. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Iodine-131-labeled L-thyroxine was administered to hypo- and hyperthyroid and euthyroid patients and the turnover rate of the hormone was measured with a whole-body counter. Blood analyses were also performed to determine the disappearance rate of L-thyroxine. In patients who had simultaneous whole-body and blood determinations, the whole-body turnover rate was always slower than that of blood; blood turnover rates were much greater in euthyroid patients taking less than normal doses of L-thyroxine. It was concluded that old methods of measuring only the blood-protein iodide and the ^{131}I uptake in the thyroid gland provided only a limited amount of information and often a misleading conception of the events in the thyroid gland and whole body. (C.O.)

35599 (ORAU-107, pp 228-30) TRACER AND TREATMENT DISCREPANCY AS A PROBLEM OF RADIOIODINE THERAPY. Edwards, C. L.; Tanida, R.; Gibbs, W. D. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Comparable whole-body retention data were collected for 50 therapeutic doses of ^{131}I for treatment of hyperthyroidism, before which an uptake of a tracer dose was determined. Whole-body retention of tracer doses (25 to 100 μCi) was measured in the low-level whole-body counter and treatment-dose retention (4 to 20 mCi) was measured in the high-level whole-body counter. In 7 of 24 determinations the whole-body retention at 48 hr was significantly different from that expected from the tracer study which possibly points up explanations for inconsistent therapeutic results. It was concluded that any evaluation of a treatment schedule for ^{131}I may be misleading if the results are not correlated with a direct measure of thyroid uptake or fate of the treatment dose. (C.O.)

35600 (ORAU-107, pp 230-3) EFFECT OF L-THYROXINE ADMINISTRATION ON WHOLE-BODY RETENTION OF ^{131}I L-THYROXINE IN RATS. Bird, E. D.; Wilson, Everett D.; Baenziger, Jacques; Gibbs, W. D. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The effect of L-thyroxine on the half-time of ^{131}I-labeled L-thyroxine turnover in thyroid-ablated rats was studied. Daily thyroxine replacement therapy was begun 10 days before the administration of a 10 μCi tracer dose of thyroxine and continued throughout the experiment. The rats wefe counted periodically in a low-level whole-body counter. Results indicated that ^{131}I-labeled thyroxine disappeared from the body in a biphasic manner. The half-time for the hypothyroid rats was 1 hr. The thyroid-ablated rats that were treated with 8 and 24 μg of thyroxine had half-times of 20 and 16 hr. The half-time of controls was 24 hr. It was concluded that in attempting to maintain normality, the biological system has remarkable ability to adjust the metabolism of thyroxine to the amount present in the body within fairly wide limits. (C.O.)

35601 (ORAU-107, pp 237-41) EFFECT OF ORAL CONTRACEPTIVES ON WHOLE-BODY RETENTION AND TISSUE DISTRIBUTION OF ^{67}Cu IN FEMALE RATS. Bird, E. D.; Mescher, David; Wilson, Everett D.; Gibbs, W. D. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Rats were given 5 or 10 μg of mestranol, an estrogen, daily; one group of rats received 5 μg of mestranol and 625 μg of norethindrone, a progestational oral contraceptive. Both agents were administered intraperitoneally. A single oral dose of 10 μCi of ^{67}Cu was given after 21 days and whole-body retention of ^{67}Cu was measured for 13 days in an animal whole-body counter. After 13 days, all animals were killed and tissue samples were assayed for ^{67}Cu. Results are presented in graphic and tabular form. The most significant changes noted when mestranol was given alone were increased ^{67}Cu concentrations in the kidney and stomach whereas, when norethindrone was added to the regimen, ^{67}Cu concentration increased in the liver, muscle, and spleen. It was suggested that the increased serum concentration of Cu after administration of oral contraceptives resulted from the redistribution of Cu with an increase in Cu concentration in the liver during the early stages of treatment, presumably because the alpha-2-globulin (ceruloplasmin) increased or enhanced absorption of dietary copper. (C.O.)

35602 (ORAU-107, pp 242-5) CHANGES IN ^{65}Zn PARTITION BETWEEN MOTHER AND PROGENY DURING AND AFTER PREGNANCY IN RATS. Bird, E. D.; Wilson, Everett D.; Mescher, David; Baenziger, Jacques; Gibbs, W. D. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The metabolism of zinc in the prenatal and postnatal period was investigated in rats by measuring whole-body retention of ^{65}Zn in normal and pregnant rats, and the subsequent transfer of ^{65}Zn through the milk to the young. A single dose of 250 μCi of ^{65}Zn was administered; whole-body counts were done daily for the first 14 days and periodically up to 84 days. The 50% whole-body retention value for normal adult females was found to be 6 days. At birth, the litter had 1.1% of the original dose that was given to the mother 41 days before parturition. The ^{65}Zn content of the litter increased to 4% of the mother's total dose during 21 days of nursing; that is, an increase of 2.9% was supplied through the mother's milk. Fecal and urinary excretion of Zn decreased during lactation. It was suggested that the data indicated that most of the transfer of Zn from mother to progeny occurred during lactation and the reduction in Zn excretion by the mother during lactation indicated a normal physiological mechanism to supply Zn to the offspring. (C.O.)

35603 (ORO-3299-20, App.A) EFFECTS OF NONRADIOACTIVE FALLOUT SIMULANT PARTICLES ON THE METABOLISM OF A SMALL PLANT SYSTEM AND THE NATURE OF PARTICLE RETENTION. (North Carolina Univ., Chapel Hill). 25p.

Preliminary investigation has indicated that in Stellaria media there is no immediate effect upon metabolism of nonradioactive fallout simulant particles dispersed in quantities of up to 50 g/ft^2. However, there is some visual evidence to indicate that over periods of a week or more, plants that remain burdened with fallout simulant particles from an initial application of 20 g/ft^2 may lose vigor, as evidenced by gradual yellowing of the affected plants. Further investigations into long term effects of nonradioactive fallout particles are therefore warranted. (auth)

35604 DETERMINATION OF HORMONAL RADIOIODINE IN SERUM WITH A CATION EXCHANGE RESIN. Wiener, Jan D.; Roos, Peter (Vrije Univ., Amsterdam). J. Nucl. Med., 9: 601-3(Dec. 1968).

A procedure is described for the determination of hormone-bound iodine in blood serum samples following the administration of a tracer dose of ^{131}I to the patient. The ^{131}I-iodoamino acids are separated from the serum in a cation exchange resin column, the iodoamino acid is eluted with ammonia, and fractions are collected for, counting in a well-type scintillation counter and results are compared with a serum sample corrected for volume difference. The method was found to be more sensitive than the protein-bound iodine test as a measure of thyroid function, and especially for the diagnosis of hyperthyrodism. (C.H.)

35605 ELECTRON MICROSCOPE STUDY OF INGESTION OF THOROTRAST BY AMEBOCYTES OF PINCTADA RADIATA. Nakahara, Hiroshi; Bevelander, Gerrit (Univ. of Texas, Houston). Texas Rep. Biol. Med., 27: 101-10(Spring 1969).

The ingestion of ThO_2 by molluscan amebocytes was studied

with the electron microscope. Colloidal ThO_2 (Thorotrast) was injected into the adductor muscle of the pearl oyster, P. radiata. At intervals ranging from 1 hr to 19 days, portions of the mantle containing amebocytes were removed for examination. Thorotrast particles when exposed to the hemolymph acquired a fibrinlike envelope. When contact with the membranous part of the pseudopod occurred, the ThO_2 particles were enveloped by folds which then became minute channels. These channels were withdrawn into the cytoplasm of the cell and the terminal portions pinched off, giving rise to minute pinocytotic vesicles. The vesicles, some containing Thorotrast particles, then migrate deep in the cytoplasm where they fused with dense bodies (lysosomes). After 24 hr all of the injected ThO_2 was localized in these organelles. Amebocytes examined at 5 and 19 days following injection of Thorotrast showed that micelles are retained in the dense bodies, the latter differing from those observed in the 24-hr specimens in that particles appear to be more compactly arranged, and also that the dense bodies decrease in size. (BBB)

35606 PROBLEMY TOKSIKOLOGII PLUTONIYA. (Problems of Plutonium Toxicology). Buldakov, L. A.; Lyubchanskii, E. R.; Moskalev, Yu. I.; Nifatov, A. P. Moscow, Atomizdat, 1969. 368p.

Detailed studies were made of the regularities in plutonium isotope ^{239}Pu distribution in organism considering plutonium penetration through the injured skin, intestinal tract, and respiratory ways. Special studies were concerned with the distribution and kinetics of plutonium exchange as a function of the rhythm of uptake, the type of introduced compound, the amount of introduced activity, and the age and the type of the animal. The microdistribution of Pu in the organs and tissues of animals was investigated. The uptake and distribution of Pu was compared with other osteotropic radioisotopes. The toxicity and clinical picture of poisoning by plutonium were also evaluated. 389 references. (R.V.J.)

35607 THE EFFECT OF THYROID-STIMULATING HORMONE ON THYROID ^{86}Rb AND ^{131}I UPTAKE IN RATS. Kapitola, J.; Schreiberova, O.; Schuellerova, M. (Charles Univ., Prague). J. Endocrinol., 43: 481-2(Apr. 1969).

Some effects of thyrotropin (TSH) on thyroid ^{86}Rb and ^{131}I uptake was studied in rats. In young female rats weighing 60 to 100 g, endogenous TSH secretion was inhibited by adding desiccated thyroid to the food for 7 days and TSH was injected in doses from 0.1 to 1000.0 milli-units. Thyroid ^{86}Rb uptake was measured 40 sec after intravenous injection of 20 μCl ^{86}Rb. The thyroid radioiodine uptake was determined 4 hr after intraperitoneal injection of 0.2 μCi ^{131}I. The results of the measurements were expressed in percentages of the dose of ^{86}Rb in 1 g, and of ^{131}I in 1 mg of thyroid tissue. The maximal effect of TSH on ^{86}Rb uptake in the thyroid gland was found after 4 hr. The discrepancy between the time-course of ^{86}Rb uptake (often used as an indicator of organ blood flow) and ^{131}I uptake in the thyroid is not yet understood. The dose-response relation shows a quantitative dependence of the ^{86}Rb uptake by the thyroid gland on exogenous TSH administration. (BBB)

35608 EFFECT OF TESTOSTERONE PROPIONATE ON THE RENAL EXCRETION OF ^{131}I IN THE RAT. Driessen, O. M. J.; Noach, E. L. (Univ., Leiden). Eur. J. Pharmacol., 3: 257-62 (June 1968).

Renal excretory mechanisms for ^{131}I were studied in ovariectomized female rats that were thyroidectomized on the previous day. Of the animals used, ½ were pretreated for 8 days with testosterone propionate, (t.p.), 2 mg daily. In two different experimental designs, using anesthetized and nonanesthetized animals, respectively, glomerular filtration rate (inulin clearance) was unaffected by t.p., whereas tubular reabsorption of ^{131}I was significantly increased. Enhancement of ^{131}I disappearance from the blood in t.p.-treated, gonadectomized-thyroidectomized rats was partly compensated for by the kidney. The t.p. caused renal retention of ^{131}I. Quantitative differences between the two experiments were caused by the procedure and body weight of the animals. These results indicated that the kidney reabsorbed more ^{131}I to compensate for losses by other pathways. Lower average ^{131}I blood levels were found in the t.p.-treated groups. The mechanism of ^{131}I retention in the kidney was not evident. The t.p. may have affected the kidney directly or mechanisms for iodine homeostasis may have been activated as a result of primary effects of testosterone propionate. (BBB)

35609 ZASTOSOWANIE RADIOAKTYWNEGO WAPNIA-47 DO BADAN NAD PRZEMIANA MINERALNA W NOWOTWORACH KOSCI. (The Use of Radioactive ^{47}Ca in Investigating Mineral Transformation in Bone Tumors). Jasinskiego, W. (ed.). Praca Wydana na Zlecenie Polskiej Akademii Nauk. Warsaw, Panstwowy Zaklad Wydawnictw Lekarskich, 1966. 217p.

The first few chapters deal with bone chemistry and metabolism. Accretion, resorption and exchange reactions in the skeleton are evaluated. Kinetics of calcium and strontium metabolism in man are presented, especially during malignancy. Methods for interpreting tracer data on bone are given. External counting and methods of localizing calcium-47 and strontium-85 are discussed from the viewpoint of diagnosing bone tumors. The use of tracers in determining calcium and strontium transfer rates in compartmental, steady-state, closed systems is presented. The selection of kinetic models is discussed. Methods of determining the dose to the tissue by calcium-47 and scandium-47 are given. Decay schemes, and methods of distinguishing calcium-47 from scandium-47 by scintillation counting are also presented. Comprehensive literature references are given at the end of each chapter. (TTT)

35610 INHIBITION OF RNA AND DNA SYNTHESIS IN VICIA ROOTS BY 8-ETHOXYCAFFEINE (EOC). Sakaguchi, Kengo; Tanifuji, Shigeyuji (Hokkaido Univ., Sapporo). Bot. Mag. (Tokyo), 81: 528-34(Nov. 1968).

The effect of 8-ethoxycaffeine (EOC), a radiomimetic chemical, on the incorporation of ^{32}P into RNA and DNA was investigated in the primary roots of Vicia seedlings. The presence of EOC during the period of labeling with ^{32}P did inhibit partially or almost completely, depending on the concentrations of EOC, the incorporation of the isotope into RNA and DNA. The extent of the inhibitory effect by EOC was approximately identical among the fractions of rRNA, mRNA, and the low molecular-weight RNA fraction consisting of tRNA and 5 to 6S RNA, thus indicating that the action of EOC on chromatin is not of preferential nature to the nucleolar organizer region, though EOC is known to induce the chromosome breaks that are extremely localized to the secondary constriction. (NSA of Japan)

35611 THE MOBILITY OF ^{65}Zn IN TRIFOLIUM SUBTERRANEUM L. AND ANTIRRHINUM MAJUS L. Millikan, C. R.; Hanger, B. C.; Bjarnson, E. N. (Victorian Plant Research Inst., Burnley, Australia). Aust. J. Biol. Sci., 22: 311-20(Apr. 1969).

T. subterraneum (cv. Clare) and A. majus were grown in nutrient cultures to which ^{65}Zn was added at two stages in the plants' development. It was found that the ^{65}Zn recently absorbed by the roots was preferentially routed to the youngest leaves. When the plants were transferred from radioactive to nonradioactive cultures, only a limited recirculation of ^{65}Zn took place. In T. subterraneum this was principally from the roots and hypocotyl, but also between and within some leaves, while in A. majus recirculation occurred along the stem, roots, and within some leaves. Injection of 1000 μg of nonradioactive zinc into the third true leaf of T. subterraneum failed to alter the distribution of ^{65}Zn between leaves, although it did induce movement of ^{65}Zn along the petiole into the lamina of some individual leaves. (auth)

35612 TRANSLOCATION AND REMOBILIZATION OF ^{14}C ASSIMILATED AT DIFFERENT STAGES BY EACH LEAF OF THE WHEAT PLANT. Rawson, H. M.; Hofstra, G. (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Aust. J. Biol. Sci., 22: 321-31(Apr. 1969).

The movement of ^{14}C assimilated by each leaf of the wheat plant was studied at successive stages of development from sowing to maturity. At each occasion assimilate moved to all parts of the plant but was translocated preferentially to the sink closest to the assimilating leaf. The function of supplying the developing leaves passed successively from expanded leaf to expanded leaf as the plant grew. Apart from this temporary phase of supplying the developing leaves, each exporting leaf fed in a specific direction with the lower leaves exporting downwards to the tillers and roots, and the upper leaves supplying the stem and ear. The tillers in this study never became completely independent from the main stem and, during the later stages of growth, a significant amount of ^{14}C moved from the lower leaves of the main stem and was incorporated in the tiller ears. A small percentage of the ^{14}C assimilated prior to ear emergence was finally remobilized to the ear of the main culm. More substantial amounts of ^{14}C assimilated at ear emergence were remobilized to the main ear and the tiller ears during grain filling, but quantities were less than reported by other workers. (auth)

35613 RELATIVE IMPORTANCE OF SOIL AND WATER IN THE INDIRECT CONTAMINATION OF FLOODED RICE WITH RADIOCAESIUM. Myttenaere, C.; Bourdeau, P.; Masset, M. (EURATOM, Ispra, Italy). Health Phys., 16: 701-7(June 1969).

The relative importance of soil and water in the indirect contamination of flooded rice with radiocaesium was investigated in model rice fields, using a double tracing technique. Roots were found to contain relatively much more ^{134}Cs (coming from the soil) than ^{137}Cs (from the water), whereas the reverse was true for the other plant parts and especially for the caryopsis. Further ex-

periments are needed to explain this lack of isotopic equilibrium within the plant. Flooded rice absorbed 30 to 100 times more Cs from the water than from the soil. The ^{137}Cs activity of the plants was related to the average activity of the water, both in time and in space. At the end of the experiment (13 weeks) the soil of the 5 plots had fixed from 41 to 64% of the ^{137}Cs brought with the water. Concentration factors between plants and water were quite similar to those observed in nutrient solution culture, which confirms the importance of water as a vector of Cs contamination to flooded rice. The upper layer of soil was depleted in Cs to a much greater extent by the surface roots than the lower layers by the normal root system. (auth) (UK)

35614 THE BINDING OF COLLOIDAL SUSPENSIONS OF RADIOACTIVE GOLD ^{198}Au BY THE LYMPHOID TISSUE WITH SPECIAL REFERENCE TO THE LYMPH NODES AND THE THYMUS. Doroszewski, Jan; Kapuscinska, Barbara. Pol. Przegl. Radiol. Med. Nukl., 33: 207-14(Mar.-Apr. 1969). (In Polish).

The distribution of ^{198}Au in the lymphoid tissue was investigated after intravenous and subcutaneous injection of colloidal suspensions of ^{198}Au in rats. The spleen, lymph nodes, thymus, liver, and blood were examined. The most important finding was that thymus binds the colloidal ^{198}Au to a lesser degree than the lymph node tissue. Quantitative data are presented on the distribution of the isotope in other tissues. The results are interpreted in terms of the role of the thymus in the colloidopexic phenomena, considering the hypotheses of the role of this gland in the immunological process. (auth)

35615 SOME OBSERVATIONS ON THE DEPOSITION OF ^{241}Am IN THE THYROID GLAND OF THE BEAGLE. Stevens, W.; Stover, Betsy J.; Bruenger, F. W.; Taylor, G. N. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Radiat. Res., 39: 201-6(July 1969).

The distribution of ^{241}Am in the thyroid glands of three beagle dogs after intravenous injection was studied. The glands were removed, frozen immediately in liquid N_2, and counted. Later the thyroid tissue was homogenized and separated into fractions by differential centrifugation. Eighty-five to ninety per cent of the ^{241}Am was found with the crude fibrous residue. Combining this fibrous material with cell nuclei and membranes accounted for more than 90% of the total activity found in the thyroid. Only very small quantities were found with microsomes, mitochondria, and in the 105,000 × g supernatant. It is concluded that ^{241}Am is selectively bound by the connective tissue elements of the thyroid. The concentration of ^{241}Am in thyroid connective tissue was found to be 337 times that of a sample of subcutaneous loose connective tissue and 4 times that of connective tissue derived from the liver. (auth)

35616 EFFECT OF AN EVALUATED IRON AND PROTEIN DIET ON PLUTONIUM EXCRETION IN URINE. Campbell, E. E.; Moss, W. D.; Stein, P. C. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 16: 764-5(June 1969).

A study was undertaken to determine the effect of increased iron intake, via normal diet, on the urinary excretion rate of Pu. The subject was a 48 year old man, exposed to Pu, eleven years previously, in the form of oxide and nitrate slurry by injection from a broken flask. Seventy days after the exposure the body burden was estimated as 50,000 dis/min. Results indicated that changes in diet did not affect the urinary excretion of Pu during the sampling period. (UK)

35617 RETENTION OF RADIUM DUE TO INGESTION OF BRAZIL NUTS. Gabay, J. J.; Sax, N. I. (New York State Dept. of Health, Albany). Health Phys., 16: 812-13(June 1969).

A study was made of the level of body burden of ^{226}Ra that would be attained by adults ingesting large amounts of these nuts. A total of 500 g of shelled nuts was eaten by each of six people over set periods of time, and urine and fecal samples were taken for Ra analysis. The nuts varied widely in Ra content, not only between batches, but also between samples within a batch. The average Ra concentration was 930 pCi/kg of kernel, with values ranging from about zero to 1640 pCi/kg. As a result of these variations an exact material balance could not be obtained between amount ingested and that excreted. Urine/fecal ratios are shown in tabular form. Lack of absorption of ^{226}Ra through the gastro-intestinal tract was indicated, and the studies seem to show that little of the Ra is absorbed by the body. (UK)

35618 FIXATION OF ^{137}Cs BY URINARY CALCULI. Kaspar, L. V.; Norris, W. P. (Argonne National Lab., Ill.). Health Phys., 16: 798-800(June 1969).

It was observed, during a study of the toxicity of ^{137}Cs in pure-bred beagle dogs, that ^{137}Cs may be concentrated and retained tenaciously in urinary calculi composed of struvite ($MgNH_4PO_4 \cdot 6H_2O$). (auth) (UK)

35619 COMPARISON OF ^{137}Cs METABOLISM IN THE BEAGLE DOG FOLLOWING INHALATION AND INTRAVENOUS INJECTION. Boecker, B. B. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys., 16: 785-8(June 1969).

Recent studies indicated that distribution and excretion patterns for ^{137}Cs inhaled as CsCl by the beagle dog are similar to those reported for dogs and mice chronically exposed to ^{137}Cs by ingestion and for a dog given ^{137}Cs intravenously. To determine more directly what effect, if any, the route of administration has on the subsequent metabolism of ^{137}Cs, two experiments were conducted to compare the biological behavior of inhaled and intravenously injected $^{137}CsCl$. (auth) (UK)

35620 PROTECTIVE AGENTS FOR PROMOTING RADIOISOTOPE EXCRETION. Strain, William H.; Pories, Walter J.; Peer, Richard M.; Dattilo, Elaine S.; Scroger, Janet N. (Univ. of Rochester, N. Y.). Trans. Amer. Nucl. Soc., 12: 59-60(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35621 DEIODINATION OF ^{131}I-SERUM ALBUMIN UNDER VARIOUS PROTEIN NUTRITION CONDITIONS. I. DEIODINATION AFTER PARENTAL DELIVERY. Bergner, H. (Humboldt-Univ., Berlin). Arch. Tierernaehr., 17: 247-56(July 1967). (In German).

Growing rats were given intraperitoneal injections of 2.5 μCi ^{131}I-serum albumin per 100 gm. With optimum diets up to 90% of the pulse rate administered was recovered from the urine after the first 24 hours. If the experimental animals received a gelatin diet or a protein-free diet over a period of several days or weeks a highly significant decrease in the urinary pulse rate was observed compared with that of the control group. Absorption of ^{131}I-serum albumin injected intraperitoneally proceeded very rapidly during the first 2 hours. After 2 hours about 30% of the amount of radioactivity injected was detected in the abdominal cavity. After 6 hours the level was reduced to 20%. In blood about 10% of the pulse rate injected was present after 2 hours and about 15% were found after 6 hours whereas only 1.5–3% of the total amount of radioactivity was found to be constantly contained in the liver. (auth)

35622 THE METABOLISM OF ^{137}Cs INHALED AS $^{137}CsCl$ BY THE BEAGLE DOG. Boecker, B. B. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Proc. Soc. Exp. Biol. Med., 130: 966-71(Mar. 1969).

Results are presented for a group of beagle dogs given single, short inhalation exposures to a CsCl aerosol contaminated with ^{137}Cs. The mean biological half-life derived from the long-term component of whole-body retention was 42 days before, and 36 days after, a colony-wide diet change. For times greater than about 10 days post exposure, approximately constant percentages of the body burden were excreted each day in the urine and feces. The U/F ratio normally fell between three and seven. Highest tissue concentrations of ^{137}Cs were observed in skeletal muscle, mandibular salivary glands, and kidneys while the lowest were in lung, skin, fat, and bone. These results indicate that since ^{137}Cs is very soluble in body fluids, the route of administration has very little effect on its subsequent distribution and excretion. (auth)

35623 ECTODESMATA IN RELATION TO BINDING SITES FOR INORGANIC IONS AND UREA ON ISOLATED CUTICULAR MEMBRANE SURFACES. Franke, Wolfgang (Univ., Bonn). Amer. J. Bot., 56: 432-5(Apr. 1969).

The binding of radiocalcium and radiochlorine to structures in tomato fruit and onion leaves was studied. Penetration and binding of radioactive ions in isolated cuticles of green onion leaves did not occur along the whole cuticular membrane but were restricted to pointlike areas of a characteristic distribution as demonstrated by microradioautography. Comparison of the localization of these binding sites in isolated cuticles and of ectodesmata in outer epidermal walls revealed that the pattern of radioisotope binding sites coincided with that of ectodesmata. It was concluded that in intact epidermal cells the isotopic binding sites in the cuticle lie on top of ectodesmatal spaces in the wall, and that together they form combined pathways of favored penetrability for aqueous solutions which are to be absorbed or excreted. In the tomato fruit cuticle the radioisotope ion binding was demonstrated to occur also in pointlike areas; however, these were not distributed in rows or groups but dispersed over the whole area above the walls. However, it was not possible to demonstrate ectodesmata in the outer walls of tomato fruit epidermis. (BBB)

35624 RETENTION AND PASSAGE OF CALCIUM AND STRONTIUM IN STEMS OF PHASEOLUS VULGARIS AS MEDIATED BY XYLEM STREAM FLOW RATE AND DINITROPHENOL.

Emmert, Fred H. (Univ. of Connecticut, Storrs). Physiol. Plant., 22: 246-52(1969).

The passage and retention of ^{45}Ca and ^{89}Sr were studied in the stem as influenced by flow rate of the ascending stream, and also by introduction of the respiratory inhibitor 2,4-dinitrophenol to the stream. Solutions containing 6000 cpm/μl ^{45}Ca or 4000 cpm/μl ^{89}Sr were forced through the bean stem sections, and solute which completed passage to the exudate was considered indicative of the nutrition normally available to the plant top. Tests were conducted over 2 widely different xylem stream flow rates, and with or without the addition of dinitrophenol to the source solution. Approximately identical amounts of ^{45}Ca or ^{89}Sr were introduced into the stem for all test situations. In all cases, the stem retained the bulk of introduced ^{45}Ca and ^{89}Sr and allowed only a fraction (~25%) to complete passage to the exudate. Stream flow rate influenced the extent of retention. At the high (vs the low) flow rate, less ^{45}Ca and ^{89}Sr (either as absolute or percent values) were retained in the stem and a corresponding greater amount passed to the exudate. The relative behavior of ^{89}Sr to ^{45}Ca is shown by the Observed $Ratio_{Sr:Ca}$ (O.R.): O.R. ^{89}Sr, ^{45}Ca = (Ratio: $^{89}Sr/^{45}Ca$ sample)/Ratio: $^{89}Sr/^{45}Ca$ precursor). An O.R. greater than 1.0 indicates an increase in Sr to Ca in the sample relative to the precursor. Conversely, a value below 1.0 denotes a decrease in Sr to Ca in the sample relative to the precursor. Stem O.R. values exceeded 1.0 under both flow rates. A preferential retention of ^{89}Sr over ^{45}Ca in the stem is thus indicated. Such discrimination was increased by 2,4-dinitrophenol. (BBB)

35625 ACUTE RADIOTOXICITY OF ^{144}Ce–^{144}Pr AFTER INTRAVENOUS ADMINISTRATION TO SHEEP. Sullivan, D. J.; McDonald, T. P.; Bell, M. C. (Univ. of Tennessee, Oak Ridge). Cornell Vet., 59: 236-49(Apr. 1969).

Eight mixed-breed wether lambs, weighing 24 to 30 Kg, were given single intravenous injections of ~10 mCi of carrier-free ^{144}Ce (0.33 to 0.42 mCi/Kg). Five sheep were killed at predetermined times after injection; 4 hr and 1, 3, 5, and 9 days. The other 3 treated sheep were permitted to survive as long as possible. Two were killed while moribund, 1 on the 13th and the other on the 18th day. The eighth sheep died 24 days after injection. Degenerative changes in hepatocytes and in cells of the bone marrow were seen. The changes in the hepatocytes were apparently due to active uptake of radiocerium by the cells, while bone marrow changes were attributed to radiations emanating from radiocerium contained in the bones. Regeneration of the bone marrow was evident 24 days after injection, but entrance of granulocytes into the peripheral circulation was impaired, and bacteremia developed as a terminal event. Radiocolloid formation did not occur, and no radioactivity was observed in phagocytic cells of the reticuloendothelial system. It was found earlier that ionic radiocerium formed a complex with serum globulins which was rapidly fixed by hepatocytes. Radioactivity in the fluid portion of the blood and in hepatocytes of sheep was seen 4 hr after intravenous injection of ionic $^{144}CeCl_3$. This indicates that radiocerium is transported in the plasma. Failure to observe radioactivity in phagocytic cells indicates that no radiocolloid was formed in the body and supports the view that ionic radiocerium does not necessarily become colloidal on contact with blood. However, failure to find radioactivity in phagocytic cells conflicts with the results of previous studies. The presence of radioactivity in the blood 13 days after injection suggests continuing redistribution of ^{144}Ce in the sheep throughout this period. Death observed 24 days after injection of radiocerium was apparently due to the hemorrhagic syndrome of acute radiation sickness, complicated by terminal bacteremia. (BBB)

35626 HIGH-RESOLUTION AUTORADIOGRAPHY OF INTRACELLULAR PLUTONIUM. Lindenbaum, Arthur: Smoler, Martin H. (Argonne National Lab., Ill.). Science, 165: 192-4 (July 11, 1969).

Intracellular incorporation of polymeric plutonium injected into mice was demonstrated in liver and spleen by electron-microscopic autoradiography. The observations are not inconsistent with other evidence indicating the association of plutonium with lysosomal components. Early results with a quantitative electron-microscopic technique may lead to microdosimetry of cells and cellular components. (auth)

35627 THE EFFECT OF LOCAL ANESTHETICS ON THE TISSUE CLEARANCE OF ^{131}I. Andreas, M.; Krasselt, M. (Karl-Marx-Univ., Leipzig). Deut. Zahnaertzl. Z., 22: 420-2(Feb. 1967). (In German).

The effects of mixtures of procaine, carbocaine, Xylocaine, and baycaine with adrenaline or l-noradrenaline on clearance of intramuscularly injected ^{131}I in rabbits were studied. Differences in clearance were measured by the ratio obtained by comparison of rates of disappearance at 2 intervals after injection. The clearance rates of procaine and baycaine were not altered by addition of 0.005% l-noradrenaline, but this additive increased the clearance rate of ^{131}I when it was used with Xylocaine. The clearance of all 4 anesthetics was very similar when no adrenaline or noradrenaline was added. The preparations that yielded the most rapid clearance rates were Xylocaine with 0.005% noradrenaline and baycaine with a combination of 0.002% adrenaline and 0.002% noradrenaline. (BBB)

35628 EFFECT OF A SINGLE HYDROCORTISONE INJECTION ON THE ^{131}I UPTAKE AND THE HISTOLOGICAL STRUCTURE OF THE THYROID IN NEWBORN DOGS. Vallent, K.; Hernady, T. (Univ. Medical School, Budapest). Endokrinologie, 53: 337-40(1968).

Radioiodine incorporation in the thyroid gland and changes in its histology were studied in newborn dogs injected with hydrocortisone (10 mg/100 g, intramuscularly). The steroid was injected to induce involution of the thymolymphatic system (TLS). A 20-μCi dose of ^{131}I was given and ^{131}I uptake by the thyroid was determined 2, 24, and 48 hr later. Six weeks after the neonatal hydrocortisone injection, the animals displayed an invariably significant reduction of radioiodine uptake by the thyroid at all 3 periods after the administration of the isotope. Six weeks after the neonatal hydrocortisone injection the thyroid gland of animals showed a considerable degree of hypofunction. The lumina of the thyroid acini were enlarged, filled with colloid, and the acinal epithelium had become flat. Since it is probable that thyroid hormone promotes a hyperplastic growth of the TLS, the possibility was considered that, following a single neonatal injection of hydrocortisone, a decrease in the production of thyroid hormone may contribute to the permanent involution of TLS. Considering that the newly born animals received but a single injection of hydrocortisone, and the radioiodine uptake of the thyroid was examined 6 weeks later, the authors concluded that decreased thyroid activity may not have been due to a still existing high blood level of hydrocortisone. A single neonatal injection of hydrocortisone, apart from inducing a permanent involution of TLS, affects thyroid functions as well. (BBB)

35629 THE BEHAVIOR OF RADIOACTIVITY IN THE BLOOD AND IN THE HEMATOPOIETIC SYSTEM AFTER INJECTION OF ^{32}P IN CASE OF CHRONIC LYMPHADENOSIS. Kranz, D.; Stieglitz, R. (Pathologisches Institut, Berlin. Univ. der Charits, Berlin). Folia Haematol. (Leipzig), 88: 330-6(1967). (In German).

The distribution of radioactivity was examined after ^{32}P injection in 8 patients with chronic lymphadenosis. Application was made intravenously, intralienally and in enlarged lymph nodes. The high level of blood activity in patients with chronic lymphadenosis after ^{32}P injection in an enlarged lymph node was partially explained by an increased washing out of marked lymphocytes. Unexplained daytime fluctuations and unknown mechanisms of regulation may be supposed to be present in this disease. (auth)

35630 THYROID GLAND FUNCTION IN RATS FED A DIET DEFICIENT IN TOCOPHEROL AND UBIQUINONE. II. UPTAKE OF ^{131}I AND MORPHOKINESE OF THE RAT THYROID GLAND. Boguth, W.; Sernetz, M. (Univ., Giessen, Ger.). Int. Z. Vitaminforsch., 37: 412-15(1967). (In German).

Results of thyroid uptake of ^{131}I were compared with the thyroid activity index in rats fed on a vitamin E-deficient diet or hypothysectomized. Rats fed the deficient diet showed low ^{131}I uptake by the thyroid gland. After subsequent addition of vitamin E or injection of thyroid-stimulating hormone the uptake of ^{131}I remained very low. Uptake of ^{131}I in the deficient animals ranged from 5 to 13%, as compared to 39% in untreated rats. (BBB)

Radiation Effects

Refer also to abstracts 35102, 35157, 35174, 35176, 35184, 35190, 35236, 35723, 35848, 35852, and 35956.

35631 (AD-681372) EFFECT OF MIXED GAMMA-NEUTRON RADIATIONS ON THE SPECTRAL ABSORPTION OF INDOCYANINE GREEN. Davis, L. W.; Brown, J. A.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Sept. 1968. 14p. (AFRRI-TN-68-7). CFSTI.

Blood from beagles and aqueous solutions of indocyanine green were separately irradiated with mixed gamma-neutron radiations at five doses from 0.53 to 48 kilorads. The light absorption of the irradiated dye in combination with irradiated blood was characterized. In addition, unirradiated dye was mixed with irradiated blood and similarly studied. The shape of the absorption spectrum was the same for all samples; the absorptivity of unirradiated dye was unaffected by mixing with irradiated blood; and the absorptivity of irradiated injectable solutions (5 mg/ml) was unchanged. (auth) (TAB)

35632 (AECD/RB-10) EFFECT OF GAMMA IRRADIATION ON THE ASCORBIC ACID CONTENT OF AMRITSAGAR BANANAS. Siddiqui, A. K.; Amin, M. R.; Matin, M. A.; Hossain, M. A.; Ahmed, M. U. (Atomic Energy Centre, Dacca (Pakistan)). Aug. 1968. 10p. Dep.

The effect of irradiation on the ascorbic acid content of Amritsagar bananas immediately after irradiation and with different storage times was investigated by irradiating banana fruits in the dose range 0 to 60 Krad. The effects of normal and inert atmospheres were also observed. It was found that irradiated fruits have consistently higher content of ascorbic acid than the control ones at any period of studies. Irradiation under nitrogen atmosphere appears to have a beneficial effect on the ascorbic acid content particularly at the high dose level. (auth)

35633 (JPRS-47582) SPACE BIOLOGY AND MEDICINE, VOL. 2, NO. 6, 1968. Translation of Kosm. Biol. Med., 2: No. 6, 3-96(1968). 136p. CFSTI.

Separate abstracts were prepared in three of the 16 articles in this English-language translation of the Russian-language periodical Kosmicheskaya Biologiya i Meditsina. The thirteen remaining articles deal with non-radiological aspects of space flight research and technology. (E.R.B.)

For abstracts of individual papers see: 35634, 35869, and 35932.

35634 (JPRS-47582, pp 36-45) EFFECT OF A SIMULATED MARTIAN ENVIRONMENT ON CERTAIN ENZYMES. Belikova, E. V.; Komolova, G. S.; Egorov, I. A. Translated from Kosm. Biol. Med., 2: No. 6, 25-31(1968).

The resistance of enzymes, RNAase, amylase and trypsin, to a simulated Martian environment was investigated. It was found that in the simulated Martian atmosphere, insolation excluded, solutions of the tested enzymes were better preserved than on the earth at 4°C. After the introduction of the insolation factor the tested enzymes were activated as a result of a 4-hr exposure to the Martian environment. The enzymes can be arranged in the order of their stability as follows: amylase, RNAase, trypsin. When added to the enzymic solutions, glycerin produced a stabilizing effect on all the enzymes in the simulated Martian environment, excluding the insolation factor, and exerted a protective effect on RNAase and trypsin, with the insolation factor taken into account. The pigments carotene and melanin served as protectors for the enzymes tested against the activating uv effect in the simulated Martian environment. Melanin proved to be more effective for amylase whereas carotene appeared to be more effective for RNAase. (auth)

35635 (UCLA-12-725) EFFECT OF IONIZING RADIATION ON THE BIOCHEMICAL DIFFERENTIATION OF THE RAT BRAIN. de Vellis, Jean; Schjeide, Ole A. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT(04-1)-Gen-12. 38p. Dep. CFSTI.

Irradiation (100 R to 1500 R) to the heads of two-day-old rats inhibited differentially the subsequent developmental increases of nucleic acids, individual enzymes, total protein, myelin and total lipid in the rat brain stem and cerebral hemispheres. When irradiation was administered at later ages a decrease in inhibition was observed with increasing age. However, the age at which radioresistance started differed widely between parameters. Glycerol phosphate dehydrogenase (GPDH) (E.C. 1.1.1.8) and isocitrate dehydrogenase (E.C. 1.1.1.42) were radiosensitive during a longer period of their development than malate dehydrogenase (E.C. 1.1.1.37), lactate dehydrogenase (E.C. 1.1.1.27) and malic enzyme (E.C. 1.1.1.40). Myelination was found mostly radioresistant by the time of its onset. Observed inhibitions took place after a delay; they were dose-dependent and showed no recovery to normal levels. Cortisol injections had no effect on the radiation-inhibition of GPDH development (GPDH level is controlled by cortisol in the normal brain). Cortisol induction of brain GPDH in adrenalectomized rats was inhibited by irradiation. Incorporation of labelled precursors into DNA, RNA and protein was depressed by neonatal irradiation at 2 days of age. Uridine incorporation into RNA was still affected by irradiation at 19 days of age. Inhibition of DNA synthesis in the neonatal rat brain was complete by 12 hours post-irradiation. Recovery occurred several days later and irradiated rats seemed to synthesize more DNA at that time. Irradiation at doses of 100 to 200 R at any age caused DNA degradation. On the other hand, degradation of RNA and other compounds appeared almost negligible. Actinomycin D was found to inhibit the developmental pattern of several parameters in a manner similar to x-irradiation. It is tentatively concluded that ionizing radiation affects cell differentiation by altering the pattern of proteins synthesized at the level of transcription. Inhibition at the level of transcription is probably related to DNA damage. (auth)

35636 CHANGES OF PULMONARY FATTY ACIDS IN THE RAT AFTER TREATMENT WITH LETHAL AND SUBLETHAL DOSES OF X RAYS. Bobbio Pallavicini, E.; Slaviero, G. E.; Ricotti, V. (Univ., Pavia, Italy). Arch. Sci. Med., 125: 87-92 (Mar. 1968). (In Italian).

Alterations induced by lethal and sublethal doses of x rays pulmonary fatty acids in albino rats were studied. Gas chromatography of the methyl esters of the fatty acids showed a constant reduction in C_{18}, and a percentage increase in C_{18}-H_2, C_{18}-H_4, C_{18}-H_6 (oleic, linoleic, linolenic). The data as a whole thus point to a reduction in the degree of desaturation of fatty acids in the lung of irradiated animals in contrast with the alterations observed in other organs. (auth)

35637 EFFECT OF ULTRAVIOLET IRRADIATION ON THE MINERAL UPTAKE AND OSMOTIC BARRIER OF CERTAIN BACTERIA. Mukherji, A. (Central Drug Research Inst., Lucknow, India); Mukherji, V. Indian J. Med. Res., 56: 788-93(June 1968).

The effect of uv irradiation on the uptake of Na, K, and Cl by Escherichia coli, Micrococcus pyogenes var aureus, and Bacillus subtilis was investigated. After an hour's incubation at 37°C the bacteria were irradiated with uv light for 2 hr from Soltan lamp at a distance of 120 cm. Bacteria irradiated with uv light took up more mineral ions than nonirradiated bacteria and had higher mineral concentration than the medium. Irradiated E. coli took up the greatest amount of K, viz., 1.5% as against 1.35% by B. subtilis, and 1.42% by M. pyogenes var aureus. In M. pyogenes var aureus, increased uptake of minerals in irradiated samples might have been due to activation of transport enzymes. (BBB)

35638 EFFECT OF X IRRADIATION AND BURSECTOMY ON INTERFERONS INDUCED IN CHICKENS BY NEWCASTLE DISEASE VIRUS. Lomniczi, B.; Pethes, G.; Kemenes, F. (Veterinary Medical Research Inst., Budapest). Z. Immunitaetsforsch., Allergie Klin. Immunol., 137: 314-19(Apr. 1969).

Induction of interferon (IF) by Newcastle disease virus (NDV) was studied in x irradiated and bursectomized chickens. Irradiation caused measurable effects on bursa and spleen as indicated by reduction of their weights. Birds exposed at 1000 R a few hours prior to induction of IF had early IF identical with and late IF slightly inferior in titer to the corresponding IFs measured in chickens exposed at 600 R 7 days earlier. In contrast, younger birds exposed at 700 R with concomitant severe clinical symptoms 7 days later had no demonstrable early IF, while the late 18- to 20-hr peak was at most 50% lower and production of late IF commenced with some delay. Bursectomy on the day of hatching had by itself no influence on the time course of either early or late IF production. The early IF peaks of bursectomized birds were lower as compared to controls, the difference was not significant statistically. Exposure, however, at 600 R effected a 5- to 6-fold decrease of the early IF peak and delayed the late peak. Nevertheless, the late peak developing by the 18th to 20th hr showed practically no deviation from normal. The same was found for IF peaks of birds bursectomized and exposed at 600 R. Since there was no demonstrable additive effect, reduction of early IF as well as delay of late IF were very likely due exclusively to irradiation. These findings indicate that the 2 humoral protective mechanisms IF production and antibody production are unrelated. The bursa-dependent large lymphocytes and plasma cells appear to play no role in IF production even in the intact animal. (BBB)

35639 EFFECT OF IONIZING RADIATION ON PASSIVE TRANSPORT OF SODIUM ION INTO HUMAN ERYTHROCYTES. Kankura, Takako (National Inst. of Radiological Sciences, Chiba, Japan); Nakamura, Wataru; Eto, Hideo; Nakao, Makoto. Int. J. Radiat. Biol., 15: 125-36(1969).

By the use of a Sephadex column, human erythrocytes were successfully separated from $^{22}NaCl$ which had been added to the medium. By this new method, the effects of irradiation on ^{22}Na uptake into the erythrocytes at 0°C were examined. The uptake increased after γ-irradiation even if the dose were lower than 100 R. The increase was partially suppressed if the cells had been incubated at 37°C after irradiation. The energy metabolism in red cells, however, was not involved in this phenomenon, since the changes were not affected by substrates and inhibitors which brought about changes in the ATP content of the cells. The presence of Ca^{2+} and Mg^{2+} in the suspending medium did not affect the uptake after irradiation, whereas EDTA increased and fluoride decreased it. The radioprotective effects of AET and of MEA were observed. (auth)

35640 MECHANISM OF THE SIMULTANEOUS EFFECTS OF IONIZING RADIATION AND FIBROPLASTIC DUST. Sevc, Josef. Prac. Lek., 21: 49-55(Mar. 1969). (In Czech).

The combined effects of fibroplastic dust and alpha emitters in white-mice were investigated in two experimental series; repeatedly and in single experiment. Administration of dust was carried

out by cristoballit by iv injection in doses of 3.0 mg. As alpha emitter, ^{239}Pu was used in colloid form of plutonium nitrate by iv injection in doses of 0.005 μCi to 0.3 μCi as well. Three months later the inhibitory effect of the alpha emitter on production of collagenous proteins was proved. The effect of alpha emitter does not depend on the presence of silicotic fibrosis, however its inhibitory effect on collagen formation in the animals liver was proved even without administration of fibroplastic dust. By investigation of incorporation ^{14}C proline in the collagenous and noncollagenous proteins the increased degradation of the soluble form of hydroxyproline as well as the decreased synthesis of soluble hydroxyproline and proline was proved. The decreased incorporation of ^{14}C proline in noncollagenous proteins indicated that synthesis of noncollagenous proteins was inhibited as well and that the changes observed were caused by the unspecific effect of alpha emitter on protein-synthesis. The simultaneous effect of fibroplastic dust and alpha emitter is enabled by cumulation of alpha emitter in fibrotic modules. It may be presumed (for which arguments are presented), that the changes observed are caused by the effect of alpha emitter, i.e., in the case of collagenous proteins to fibroblast. Evidence is presented of speeded maturation of collagens in vivo in silicosis. (auth)

35641 ANALYSIS OF THE EARLY DISTURBANCE OF ION TRANSPORT IN IRRADIATED ERYTHROCYTES. Gerasimova, G. K.; Nakhilnitskaya, Z. N. (Inst. for Medico-Biological Problems, Moscow). Dokl. Akad. Nauk SSSR, 184: 709-12(Jan. 21, 1969). (In Russian).

It has been found that exposure to large doses of ionizing radiation results in a reduction of the transport of Na ions in human erythrocytes. The problem was further investigated by studying the changes in the incorporation of ^{42}K in irradiated erythrocytes of rats during the early postradiation periods, examining also the inhibition of certain processes. The rats were exposed to 50 kR of γ radiation of a ^{60}Co source; 1 hr after exposure incubation of erythrocytes with ^{42}K Cl was started in the presence of glycolysis inhibitors. The activity of the blood and plasma was determined on the basis of the completion of incubation with the isotope and subsequent dilution with a buffer solution. The results indicated that there is a correlation between the start of the increased K ion intake by irradiated cells and the changes in the energy exchange; the effect may be attributed to changes in the active transport of the K ions. The increase of the intensity of these ions during the early post-radiation periods may be regarded as a compensation reaction which evens out changes in the ionic balance of the cells. Because of energy deficiency during the later periods, this compensating ability of the cells becomes exhausted. (TTT)

35642 HISTOCHEMICAL CHANGES OF NAD-DIAPHORASE AND GLUCOSE-6-PHOSPHATE DEHYDROGENASE OF VARIOUS ORGANS IN RAT AFTER WHOLE BODY X-IRRADIATION. Walther, Gotfried; Schmidt, Karl Juergen (Johannes-Gutenberg-Univ., Mainz). Aerztl. Forsch., 22: 278-88(Aug. 10, 1968). (In German).

The activity of glucose-6-phosphate dehydrogenase (G-6-PDH) and NAD-linked diaphorases after whole-body x irradiation with 650 and 1950 R in kidney, brain, pancreas, heart, skeletal muscle, spleen, liver, intestinal tract, ovaries, and adrenals of rats was histochemically investigated. The activity of G-6-PDH showed an increase in the above mentioned order of the organs on the first day, this increase was reduced to nearly normal values until the third day. With exception of liver, intestinal tract, ovaries, and adrenals, this increase of activity was more pronounced after 1950 R. After 1950 R these organs showed, on the first day only, a small activation, that increased considerably until the third day. These changes may be caused by an activation of the pentose phosphate cycle, which in turn may be induced by an increased glucose turnover by this enzyme system, but the most important factor seemed to be the increased requirement of ribose and NADPH. The NAD-Diaphorase showed in nearly all organs investigated an increase, followed by a decrease of activity, the intestinal tract showed a more intense decrease of activity. (auth)

35643 EFFECT OF GAMMA RADIATION ON PHENYLALANINE AMMONIALYASE ACTIVITY AND ACCUMULATION OF PHENOLIC COMPOUNDS IN CITRUS FRUIT PEEL. Riov, J.; Monselise, S. P.; Kahan, R. S. (Hebrew Univ., Jerusalem, Soreq Nuclear Research Centre, Yavne, Israel). Radiat. Bot., 8: 463-6(Dec. 1968).

External layers of citrus fruit peel evinced a marked increase in phenylalanine ammonia-lyase (PAL) activity after irradiation with 200 kRad doses of gamma radiation. Maximum enzyme activity was attained one day after irradiation. Thereafter PAL activity rapidly decreased to control values in fruits which did not show visible damage symptoms later upon storage, but remained relatively high for several days in those fruits which later showed peel damage. Accumulation of phenolics in cells was demonstrated and may be explained by the enhanced PAL activity. The connections between irradiation, enzyme activity, phenolics and damage are briefly discussed. (auth) (UK)

35644 FACTOR REDUCING ^{59}Fe INCORPORATION INTO MAMMALIAN CELLS. Dalos, B.; Doeklen, A.; Horvath, M. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Nature (London), 222: 1075(June 14, 1969).

It was found that after local x-irradiation of the spleen of rabbits a factor inducing a considerable drop of the reticulocyte number was released into the blood serum, this factor appearing to be either gamma globulin, or a small molecular compound attached to it. An investigation is described with a view to determining whether serum or gamma globulin from x-irradiated rabbits influences iron incorporation into red blood cells in vivo, and into bone marrow cells in vitro. The iron was injected intravenously as ^{59}Fe citrate and the activity in red blood cells was determined up to five days later. Incorporation was reduced by pre-injection of serum or gamma globulin from irradiated animals, as compared with controls. In the in vitro experiments nucleated bone marrow cells were incubated in phosphate buffer containing serum or gamma globulin and ^{59}Fe citrate, followed by determination of activity in the acidhaematin; the spectra were identical with those of crystalline haem. No decrease of iron incorporation was found with sera or gamma globulin from animals whose liver was irradiated. It was found that the gamma globulin employed depressed the reticulocyte count of healthy animals to 39 to 70%. The studies show that the factor found in the sera of spleen irradiated animals depresses the reticulocyte count, and reduces ^{59}Fe incorporation both into circulating red blood cells and into the haem of bone marrow cells, the latter indicating a drop in haem synthesis in bone marrow cells. (UK)

35645 BEHAVIOR OF SOME ENZYME ACTIVITIES AND THE RESPIRATORY RATE OF THE LIVER OF MICE AFTER IRRADIATION IN VIVO. Waldschmidt, Mariaane; Arkenau, Elke (Univ., Freiburg i. B.). Strahlentherapie, 136: 723-8 (Dec. 1968). (In German).

One to 14 days after whole-body x irradiation with 690 R the activities of ATPase, 5'-nucleotidase, and xanthine oxidase were measured in cytoplasm and particles of mouse liver. The activities of ATPase and 5'-nucleotidase were significantly increased in fasted animals. Beginning from the third day after irradiation the ATPase activity in liver particles of fasted animals was significantly higher than after 24 hrs fasting. The activity of 5'-nucleotidase in particles of fasted animals was significantly increased six days and 12 to 14 days after irradiation. The activity of xanthine oxidase in cytoplasm was greatly diminished after 24 hrs fasting and comparatively increased two, six, and eight to 14 days after irradiation. The respiration of mouse liver mitochondria with pyruvate, α-oxyglutarate and succinate as substrates was increased after 24 hrs fasting, but not altered one to nine days after irradiation with 690 R. (auth)

35646 EARLY INCREASE IN THE MISCIBLE DEOXYCYTIDINE POOL IN RATS AFTER X IRRADIATION. Guri, Charles D.; Minot, Henry; Swingle, Karl F.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 39: 155-63(July 1969).

Intraperitoneal and intravenous injections of tracer quantities of ^{3}H- or ^{14}C-labeled deoxycytidine (CdR) were used to investigate the biologic half-life, the miscible pool size, and the turnover rate of CdR in normal and x-irradiated rats. The specific activity of highly purified CdR isolated from blood plasma samples taken at various times after injection of the tracer CdR was used as the basis for calculating these values. The mean values observed for normal rats were: biologic half-life 116 min, miscible pool 790 μg/rat (100 to 180 g), and turnover rate 7.0 mg per 24 hr per rat. The miscible pool of CdR appeared to be nonuniform, with the intracellular concentration appreciably higher than the general body-water concentration. About one-third of the total miscible CdR appeared to be intracellular. After relatively low doses of whole-body x irradiation (50 to 100 RADS), there were alterations in the turnover kinetics of CdR, but the presence of a non-steady state made computation of the above three values impossible. However, the data are fully consistent with an increase in the miscible pool size of CdR, occurring as early as 1 hr postirradiation. The data do not provide information as to the mechanism for this apparent increase. (auth)

35647 X- AND γ-IRRADIATION OF DILUTE SOLUTIONS OF CHYMOTRYPSIN: EFFECTS ON THE ENZYME. Lynn, K. R.; Orpen, Gail (National Research Council of Canada, Ottawa). Radiat. Res., 39: 15-25(July 1969).

X- and γ irradiation of 5×10^{-6} M solutions of chymotrypsin in HCl of pH 3 affected the lability of readily exchangeable hydrogen atoms in the molecule. Amino acid analyses have showed that tyrosine and tryptophan were the residues first attacked during ir-

radiation. As tyrosine apparently had no significant role in the catalytic activity of the enzyme, conformational changes and the destruction of tryptophan residues were the routes by which radioinduced inactivation of dilute solutions of chymotrypsin occurred. (auth)

35648 RADIATION EFFECTS ON THE CONNECTIVE TISSUE MATRIX. Lamberts, H. B. (Univ., Groningen, Netherlands). pp 387-96 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Reference is made to effects of irradiation on extracellular matrix or ground substance, effects that are independent of cell damage in the irradiated tissue, and have hitherto been more or less neglected, but which may have important biological consequences. Connective tissue contains, apart from cells and fibers, up to 70% or more of water, built into the matrix environment. The matrix consists mainly of mucopolysaccharide-protein complexes or mucoproteins. Among other things an immediate drop in the viscosity of synovial fluid after irradiation was observed. Methods applied to study these radiation effects are described; these include measurement of subepidermal water permeability, measurement of injection pressure in subepithelial tissue, and irradiation of synovial fluid. (UK)

35649 SOME PRACTICAL CONSEQUENCES OF THE X-RAY DEPOLYMERISATION OF THE CONNECTIVE TISSUE MATRIX. Lamberts, H. B. (Univ., Groningen, Netherlands). pp 397-408 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Mucopolysaccharides in connective tissue show great radiosensitivity and irradiation results in depolymerization reactions; there is also a negative oxygen effect. As blood vessel walls, and particularly arterial walls, contain rather large amounts of mucopolysaccharides it was considered interesting to investigate comparable irradiation effects, and studies were made of the effect of x radiation on the injection pressure in the aortic wall; an immediate pressure drop was observed. This increased permeability for water was accompanied by an increased diffusion rate for other substances, including certain dyestuffs. It was also thought worthwhile to ascertain the influence of x radiation on arteries with regard to atherosclerosis. Studies were also made on the effect of irradiation on the heart and on the eye. Results are summarised. (UK)

35650 EVIDENCE OF DNA REPAIR IN NORMAL RAT LIVER AFTER IRRADIATION. Goutier, R.; Baugnet-Mahieu, L. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Stud. Biophys., 12: 67-74(1968). (CONF-680657-1).

From 6th Annual Meeting of the European Society for Radiation Biology, Interlaken, Switzerland.

The incorporation of ^{14}C-thymidine into normal rat liver DNA is doubled within 15 min after a whole-body x irradiation of 50 R. This increase is no longer detectable 60 min after irradiation. The possibility of a repair incorporation is discussed; these observations are put in parallel with the observed recovery of thymidine kinase activity in irradiated regenerating liver. (auth)

35651 ENERGY LOCALISATION IN MATERIALS OF BIOLOGICAL INTEREST. Koch, R.; Moenig, H. (Univ., Freiburg i. B.). pp 377-85 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

It is stated that the localisation and the behaviour of radical states are not only dependent on molecular structure, but also on other parameters such as temperature, time after energy absorption, LET, environment, crystallographic conditions, etc. Very similar organic compounds show very different radical yields, which are not so pronounced when the substances are irradiated at low temperatures, but on warming up to room temperature become large. Studies are described on sulphur-containing compounds, such as the cysteines, and on other organic compounds such as the alanines, the pyridoxines, bovine serum albumin, adenine, adenosine, and its triphosphate. Irradiation was with 200-kV, 20-mA x rays to 100 kR at room temperature. ESR spectroscopy was employed. (UK)

35652 USE OF ELECTRON SPIN RESONANCE IN THE STUDY OF RADIATION EFFECTS ON SOLIDS OF BIOLOGICAL INTEREST. Mueller, A. (Kernforschungszentrum, Karlsruhe, Ger.). pp 361-75 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

ESR studies were applied to two major problems of radiation biology. The first is the identification of intermediate radical products in irradiated biological systems, and the second is the evaluation of the biological consequences of radical reactions. The following topics are discussed: identification of radicals by qualitative ESR spectroscopy (glycine radicals, protein radicals, hydrogen addition radical of thymine, radicals in DNA); quantitative ESR spectroscopy (dose-effect curves and radical saturation–amino acids, nucleic acid constituents, and DNA, and radical yields and energy transfer). (UK)

35653 GENETIC IMPLICATIONS OF DNA REPAIR. Haynes, R. H.; Baker, R. M.; Jones, G. E. (Univ. of California, Berkeley). pp 425-65 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Some of the genetic implications of DNA repair are explored. The major part of the discussion is based on the results of radiation experiments with bacteriophages and procaryotic cells. Relatively little is known about the structure and behavior of eucaryotic chromosomes, and although repair has been observed in many lower eucaryotes, it is uncertain whether such processes occur in mammalian cells. The main hypotheses emerging concerning the relation between repair and replication are enumerated and briefly discussed. Headings are as follows: general aspects of repair: dark repair of DNA structural defects (repair of intra- and interstrand crosslinks, repair plays of strand breaks); replication and repair; repair and the interpretation of inactivation curves; transcription and repair; mutation and repair; recombination and repair; the question of repair in mammalian cells. (UK)

35654 INACTIVATION OF SOME ENZYMES IN AQUEOUS SOLUTION BY ATOMIC HYDROGEN. Stein, G. (Hebrew Univ., Jerusalem). pp 467-77 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Some aspects of the reactions of atomic hydrogen with enzyme proteins in aqueous solution are examined, under the following headings: atomic hydrogen in aqueous solution; one-electron versus two-electron processes–the inactivation of the coenzyme DPN^+ by radiations; one-electron reagents and the role of metal prosthetic groups in enzyme proteins–cytochrome-C; role of reduction processes in the radiation inactivation of some biochemically important systems; reaction of H atoms with some hydrolytic enzymes (chymotrypsin, trypsin, ribonuclease). The results obtained by H-atom treatment are compared with those for ribonuclease after treatment with ionizing radiation. Partially modified enzyme molecules do not occur in the former case, but do occur in the latter case, leading to a wider spectrum of products. The results with hydrolytic enzymes are consistent with the assumption that the site of radical localization is on divalent sulphur, in which the d-electron shell serves as an electron acceptor, resulting in the formation of a semi-reduced free radical on the divalent sulphur. A further reducing H equivalent may be transferred from some adjacent aromatic amino-acid, as evidenced by the evolution of H_2S. This would indicate functional correlation divalent sulphur and aromatic amino acids in the framework of the enzyme molecule. The aromatic amino acid after this electron equivalent transfer to divalent sulphur would be partially oxidized and would then undergo oxidation to a quinonoid substance, with transfer of another electron equivalent to divalent sulphur, thus propagating an intra-molecular chain, which would be finally terminated by the interaction of two radicals, intra- or intermolecularly. The findings are consistent with the assumption that increasingly complicated organized structure need not result in indiscriminate reaction, but on the contrary the observed inactivations are due to specific localized reactions. (UK)

35655 RADIATION INDUCED DOUBLE- AND SINGLE-STRAND BREAKS IN PHAGE DNA. Dewey, D. L. (Mount Vernon Hospital, Northwood, Eng.). pp 479-84 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

A new technique is described (due to Freifelder and Davison) for measuring the number of single- and double-strand breaks in the DNA of bacteriophage, with reference to the damage caused by high LET irradiation such as carbon and argon nuclei accelerated in the Berkeley HILAC. The technique involves ejection of the DNA from

the phage head protein into a suitable medium by heating to 70°C, followed by ultracentrifuging and photography in uv light. If all the DNA molecules are of identical length they will all sediment at the same rate and the boundary between the top of the DNA and the clear supernatant will be very sharp. If some of the DNA molecules are broken, the intact molecules will sediment as before but will contribute only a proportional part of the total optical density. The broken molecules will sediment more slowly, and because of the random nature of the breaks the fragments will be of all sizes. The photograph is scanned with a microdensitometer and the transition between intact DNA and broken fragments is clearly visible on the plot of optical density along the centrifuge tube length. The proportion of optical density having the sharp boundary is measured because this corresponds to the fraction of unbroken DNA. The foregoing applies to double-strand breaks; if it is required to measure single-strand breaks the DNA is first alkali denatured to separate the strands. Comparison is made with the sucrose gradient technique. The sample must be free of other substances absorbing uv light at 260 mμ; this means that all other forms of life must be excluded, to avoid contamination by RNA. Some results with this technique are presented. (UK)

35656 METABOLIC CHANGES IN SWEET POTATO ROOTS INDUCED BY GAMMA RADIATION IN RESPONSE TO CUTTING. Ogawa, Masami; Uritani, Ikuzo (Nagoya Univ., Japan). Radiat. Res., 39: 117-25(July 1969).

Sweet potato roots were irradiated with 5 to 120 krads of ^{60}Co γ rays, and then cut into disks, that were incubated under aerobic conditions. The effects of γ radiation on metabolic changes in the tissue in response to cutting were investigated. The polyphenol content and activities of o-diphenol oxidase, peroxidase, and phenyalanine ammonia-lyase increased greatly in both nonirradiated and irradiated samples after cutting. Following irradiation with 60 krads or more the polyphenol content and peroxidase activity in response to cutting was significantly stimulated over the nonirradiated sample. On the contrary, formation of lignin-like substance was inhibited. No significant effect on o-diphenol oxidase was observed at any dose tested. In samples irradiated with 90 krads an increase in phenylalanine ammonia-lyase was correlated with the increase in polyphenol content. (auth)

35657 ULTRAVIOLET-INDUCED PYRIMIDINE DIMERS IN TETRAHYMENA PYRIFORMIS. II. IN VIVO PHOTOREACTIVATION. Francis, A. A.; Whitson, G. L. (Oak Ridge National Lab., Tenn.). Biochim. Biophys. Acta, 179: 253-7(Apr. 22, 1969).

Inactivation of T. pyriformis DNA by formation of pyrimidine dimers after uv radiation (2537 Å) and reactivation by longer wavelength uv or visible light were studied. Dimers removed from the DNA of Tetrahymena during dark repair are retained within the cell for the first 10 hr following irradiation. During photoreactivation thymine-containing pyrimidine dimers were monomerized in vivo. The monomerization of dimers during photoreactivation was found to be a function of the wavelength and intensity of the photoreactivating light and the temperature of the cell sample. Loss of dimers could be obtained with monochromatic light from 3341 Å to 4358 Å with a maximum rate at 3650 Å. The results indicated that the disappearance of pyrimidine dimers is due to monomerization by an enzymic process similar to that reported for other biological systems. However, doses of photoreactivating light that monomerize a small fraction of the dimers greatly reduce the uv induced delay in cell division, suggesting that this reduction may not be a consequence of pyrimidine-dimer monomerization. (BBB)

35658 INVESTIGATION OF RESORPTION OF AMIDOTRIZOATE (^{131}I-VISOTRAST) LABELLED WITH ^{131}I DURING GASTROINTESTINAL PASSAGE. Glaser, F. H.; Friedemann, S.; Herzmann, H. (Deutsche Akademie der Wissenschaften zu Berlin). Radiol. Diagn., 10: 25-33(1969). (In German).

The use of combinations of water-soluble contrast media and those containing barium sulfate suspension have proved valuable in the peroral study of gastrointestinal passage in one sitting. The frequency of resorption of Visotrast 370, labeled with 25 to 25 μCi ^{131}I administered orally, was studied in 120 indoor patients undergoing radiation therapy for various tumors. The resorption rate of Visotrast 370 is directly proportional to the duration of passage through the intestine. Pure water-soluble contrast medium has a shorter passage time than a combination of Visotrast 370 and Oesbaryt. Inflammatory changes in the digestive tract facilitate the resorption of water-soluble contrast media. The same effect is observed when large parts of abdomen are subjected to irradiation in course of therapy. (auth)

35659 THROMBOELASTOGRAPHIC STUDIES ON THE BLOOD OF CANCER PATIENTS AFTER IRRADIATION ADMINISTRATION OF IRRADIATED AND NONIRRADIATED COAGULATION FACTORS (RADIOHEMATOLOGIC AND RADIOBIOLOGIC STUDIES WITH AHG, EACA, PROTAMINE SULFATE, ACC-76 AND VITAMIN K_1, AND THROMBIN). Stamm, H. (Univ., Basel); Szirmai, E.; Celander, D. R. Agressologie, 10: 65-71(1969). (In German).

The effect of the following nonirradiated and ^{60}Co γ-irradiated blood coagulation factors on the thromboelastogram parameters r, k, and mE was determined: ε-aminocaproic acid (EACA), protamine sulfate, Synkavit (vitamin K_1), antihemophilic globulin (AHG), ACC-76 (Behring), and thrombin. The usual radiation dose was 2000 R. EACA in a concentration of 1/20 approximately doubled r and k in comparison with controls, lowering mE in corresponding manner. There was no difference between irradiated and nonirradiated EACA. Nonirradiated protamine sulfate (1/20) prolonged r about 10 times, k distinctly, and slightly decreased mE. The combination of AHG and ACC-76 irradiated with γ rays (2000 R) slightly prolonged k resulting from a distinct increase due to AHG and a slight reduction due to ACC-76, without modification of mE. Synkavit, whether irradiated or not with 2000 R, extended r in proportion to its concentration, extended k (the concentration 1/10 being the most favorable), and left mE unchanged, except at the dilution of 1/10 when a modification of mE appeared. Thrombin at 1.5 to 30 NIH units accelerated coagulation greatly so that r could no longer be measured, the coagulation having taken place before the apparatus started to function; at 0.3 and 0.6 NIH units, r and mE were increased. (BBB)

35660 SEASONAL CHANGES IN BRAIN METABOLISM. Baryshnikova, M. N.; Deryabina, T. I.; Karlik, L. D. pp 31-7 of Sb. Voprosy Biokhimii Golovn. Mozga. Gorky, USSR, 1966. (In Russian).

White rats, in spring-summer and fall-winter groups, were subjected to x irradiation (doses of 5000 and 1000 R). For the non-irradiated animals, the spring-summer period was characterized by a higher content of plasmalogens (I) and amide groups (II) in brain tissue protein, compared to the fall-winter period. This increase was particularly important for I and II of the water-soluble protein fraction. In that period, brain content of I and the total amount of II in the water soluble proteins increased about 1.5 fold compared to fall-winter, and that of those closely linked to the II protein increased two-fold. The content of unstable II of this protein fraction remained almost unchanged. In the spring-summer season, the total brain protein contained a somewhat higher amount of all the II fractions. Under the effect of irradiation, the brain tissue content of I increased in fall-winter from 10.4 to 13.3 mg aldehyde/g tissue, in spring-summer from 15.3 to 19.1. The II content of total brain protein decreased after irradiation (500 R) in both seasonal periods. In the water-soluble fraction, the content in II remained unchanged after irradiation (1000 R) in the fall-winter period and increased in spring-summer. (ATD)

Immunology

Refer also to abstracts 35765, 35879, 35884, 35897, 35898, and 35926.

35661 (AD-681376) CELLULAR RESPONSE OF MICE TO INFECTION WITH PASTEURELLA TULARENSIS (LVS) FOLLOWING CONTINUOUS EXPOSURE TO LOW DOSE RATE GAMMA RADIATION. Silverman, Myron S.; Greenman, Vivian; McKee, Adam E.; Hadley, K.; Hodge, Frederick A. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 13, 1968. 29p. (USNRDL-TR-68-146). CFSTI.

Immune γ irradiated mice responded to infection with Pasteurella tularensis with an increased histiocytic and plasma cell mobilization. Although some pathologic lesions were seen in these mice, they occurred to a lesser degree than in either γ irradiated or non-irradiated non-immune mice. (auth) (TAB)

35662 (NYO-3695-3) A NEW APPROACH TO X-IRRADIATION AND THE IMMUNE RESPONSE. Comprising: Report for Triennium, 1966-69; Progress Report, 1968-69. Nossal, G. J. V. (Walter and Eliza Hall Inst. of Medical Research, Parkville (Australia)). Contract AT(30-1)-3695. 24p. Dep. CFSTI.

Research accomplishments during 1966 to 1969 at the Walter and Eliza Hall Institute of Medical Research are reported. Progress in the following individual research projects is reported for the triennium 1966 to 1969. Thymus interactions in the induction of immune response; antibody formation and tolerance in vitro; antigen localization patterns; low and high zone immunological tolerance; microchemistry on immunoglobins poured out by single cells in microdroplets; the irradiated animal as a tool in immunology; immunological tolerance and thymectomy; and localization of antigen incorporated in Freund's complete adjuvant. During 1968 the following investigations were conducted: isolation and characterization of proteins from single cells; antibody production

and tolerance induction in vitro; kinetics of the antibody-forming cell response; enumeration of antigen reactive cells responsive to a purified protein antigen; antigen-reactive cells in normal, immunized, and tolerant mice; induction of immunity and immunological tolerance in vitro in the absence of macrophages; stability of the tolerant state induced by high and low doses of antigen; cellular studies on tolerant animals; immune responses of neonatally thymectomized rats; cellular basis of IgM immunological memory; DNA synthesis in the development of antibody-forming cells during the early stages of the immune response; properties of colonies of antibody-forming cells in the spleens of irradiated mice; antigen-reactive cells in vitro; antigen localization and processing; phylogenetic aspects of antigen localization; cellular and humoral immunity in the marine toad; immunoglobins of the Australian lungfish; immune response of the Tautera, Sphenodon punctatum; analysis of rat immunoglobins; and an enzymatic method for the trace iodination of immunoglobins and other proteins. A list of publications is presented for the triennial and annual investigations. (E.R.B.)

35663 (ORAU-107, pp 59-61) THE INFLUENCE OF TOTAL-BODY IRRADIATION ON BACTERIAL AGGLUTININS IN HUMAN SERUM. **Balish, Edward; Pearson, Ted A. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).**

Studies on the bacterial agglutination titers of three men accidentally exposed to high levels (500 to 600 R and 100 to 200 R) of x radiation were carried out. Bacteria isolated from each patient were used to measure the presence of agglutinating antibodies in the sera. Data are presented in tabular form. In general, the victim who was exposed to the highest dose had the lowest agglutination titers; the low-dose victim had the higher agglutination titers. (C.O.)

35664 (ORAU-107, pp 61-5) THE INFLUENCE OF TOTAL-BODY IRRADIATION ON THE BACTERICIDAL ACTIVITY OF HUMAN SERUM. **Balish, Edward; Pearson, Ted A. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).**

Studies on the bactericidal capacity of serum of three men accidentally exposed to high levels (500 to 600 R and 100 to 200 R) of x radiation are reported. Organisms isolated from each person were used to evaluate his serum. Data are presented in graphic form. (C.O.)

35665 (ORAU-107, pp 260-4) FURTHER OBSERVATIONS ON THE ROLE OF ACUTE EXPOSURE RATES ON IMMUNE SUPPRESSION OF IRRADIATED MICE. **Carlson, Donald E.; Gengozian, N. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).**

The effect of acute radiation exposure rate at various times either before or after antigen administration, establishment that the exposure-rate dependence of antibody formation occurred at the cellular level, and comparison of the rate dependence of immune suppression to animal mortality were investigated in mice. Acute exposure doses consisted of 700 R at 8 R/min, 40 R/min, or 72 R/min. Serum samples were collected at five weekly intervals after antigen (sheep erythrocyte) injection. The effect of exposure rate on primary antibody production of transferred spleen cells exposed to 300 R γ radiation was investigated as well as the comparative effects of exposure rate upon mortality of irradiated mice and suppression of antibody formation at exposures of maximum rate sensitivity for each end point (1000 R for mortality and 700 R for immune suppression). Results are presented in graphic form and are briefly discussed. It was suggested that exposure-rate sensitivity of the immune system is separate from systemic effects related to animal mortality and that radiation death is not a measure of immune incompetence. (C.O.)

35666 (ORO-1749-22) STUDY OF THE EFFECTS OF RADIATION ON HOST-PARASITE RELATIONSHIPS. Progress Report. **Jones, Arthur W. (Tennessee Univ., Knoxville. Dept. of Zoology and Entomology).** June 15, 1969. Contract AT(40-1)-1749. 14p. Dep. CFSTI.

Host-parasite relations of the bile duct tapeworm Hymenolepsis microstoma to the intermediate host, larvae of the flour beetle Tribolium confusum, and the final host, mice, are summarized. Immune reactions in infested mice are emphasized. The effects of single 5000 or 7500 R doses of x radiation on fecundity and morphology of the adult cestode were studied in specimens of H. microstoma removed from mice, irradiated in vitro, and transplanted into other mice. Irradiation caused a delay in egg production and a number of abnormal proglottids. An increase in the number of chromosome aberrations was also noted in irradiated cestodes. Larvae of Tribolium confusum were infested with cestode oncospheres and exposed to x radiation daily for six days postexposure. Retardation of development and morphological anomalies were noted. A protective effect of anoxia was demonstrated in adult cestodes irradiated at doses of 2,500 to 10,000 R in a nitrogen atmosphere. The toxicity of AET for cestodes prohibited its use as a radioprotective compound. It was concluded that the radiation response of Hymenolepsis microstoma makes it a model organism for radiobiological studies. (C.H.)

35667 EVALUATION OF PREOPERATIVE EXTRACORPOREAL IRRADIATION OF THE BLOOD IN HUMAN RENAL TRANSPLANTATION. **Persson, B.; Rosengren, B.; Bergentz, S.-E.; Hood, B. (Sahlgren's Hospital, Goteborg. Univ. of Goteborg).** Transplantation, 7: 534-44(June 1969).

Extracorporeal irradiation of the blood was performed as an adjunctive immunosuppressive treatment before renal transplantation. Cobalt-60 was used as the radiation source. Eighteen patients receiving ≥9,000 rads/blood volume at ≥5 irradiation treatments before transplantation were compared with 60 control patients who did not receive any preoperative extracorporeal irradiation of the blood. There was no difference in numbers of deaths unrelated to rejection incidents in these groups of patients. There was a significantly smaller number of rejection incidents among the treated patients during the second to fourth weeks after transplantation. There was a significantly higher percentage of functioning transplants in the treated group, when related to the total number of transplanted kidneys. Relatively more kidneys were lost because of rejection in the untreated group. This might explain why there was no striking difference of glomerular filtration rates of remaining kidneys between the groups. There was a significantly higher rate of severe infections in a group of patients receiving ≥40,000 rads of extracorporeal irradiation of the blood than in an unirradiated group, while this morbidity was low among patients receiving less than 40,000 rads. (auth)

35668 MIXED LYMPHOCYTE BLASTOGENESIS IN RESPONSE TO MULTIPLE HISTOCOMPATIBILITY ANTIGENS. **Colley, Daniel George.** New Orleans, Tulane Univ., 1968. 96p.

Thesis.

Inbred strains of rats were used as lymphoid cell donors for the mixed lymphocyte reaction (MLR), with the hope of increasing the precision of this reaction so that it might prove a more useful immunologic technique. Reactions were assayed by the uptake of tritiated thymidine or uridine. Optimal conditions for a maximal response were found to include the use of 1) lymph node cell preparations in preference to peripheral leucocytes, 2) 10% fresh rat serum as a medium supplement, 3) 3×10^6 cells/2 ml medium, and 4) harvest after four to five days incubation. Studies of the early portion of the response showed a twenty-four hour lag period prior to detectable allogenic stimulation. Unidirectional responses were measured by the use of cells, exposed to graded doses of x-irradiation, as a stimulatory but non-responsive population. Such x-irradiation studies dissected the total MLR into two disproportionate but additive reactivities. The same relative strain responsiveness was qualitatively but not quantitatively obtained in parental-F_1 hybrid one-way experiments. BNxLe combinations exhibited a considerably higher response than BNxFi mixtures although, on the basis of their Ag-B locus disparities, these two combinations should have reacted equally. Exposure of Le and Fi cells to phytohemagglutinin and addition of Colcemid® to BNxLe and BNxFi MLR demonstrated that the response differences were not dependent upon innate disparities in either total responsive or proliferative ability of Le and Fi cells. A low-grade, but significant response was detectable between the Ag-B compatible Fi and Le strains, and this reaction was found to depend solely upon responsive Fi cells. The response of Le($Ag\text{-}B^1$) cells to non-responsive BH ($Ag\text{-}B^3$) and DA ($Ag\text{-}B^4$) cells was compared singly and jointly. The ability of the Le cells to respond to the dual Ag-B complex stimulus was equal to the sum responses of the two individual Ag-B complex stimuli. The additive relationship of these stimuli was maintained throughout the course of the blastogenic and proliferative response. These results indicate that the response summation was produced by two independent, simultaneous reactions. Such responses appeared to be founded in separate unipotential cell pools. If the MLR is a true primary immune response, this interpretation is compatible with a clonal selection hypothesis. (Disser. Abstr.)

35669 THE BEHAVIOR OF ANTIBODY PLAGUE FORMING CELLS AFTER IRRADIATION. **Roseler, P. H.; Stender, H. St. (Institut fuer Klinische Radiologie, Hanover).** Z. Immunitaetsforsch., Allergie Klin. Immunol., 134: 81-90(Nov. 1967). (In German).

With the antibody-plaque-technique of Jerne and Nordin, the number of hemolysin producing spleen cells after radiation with 250 R was examined. The radiation either was given 48 hr before or 48 hr after the intraperitoneal application of 4×10^8 sheep red cells. If the radiation was given 48 hr before the application of antigen the rise of plaque-producing cells was delayed 2 days and

its maximum rate became significantly reduced to 20% the rate of the control animals. The serum's hemolysin titer was reduced 25%. If the radiation is given 48 hr after antigen application, the absolute number of plaque-producing-cells a day after radiation will be lowered to a third in comparison with the number of control animals; the rate of the maximum is delayed one day, and the maximum rate only slightly but not significantly reduced. The hemolysin's maximum rate in the serum is lowered to 65% compared with the control's rate. It is not certified, if the alteration of antibody synthesis after x irradiation at various times corresponds either to the different radiosensitivity of antibody-forming cells or to a damage of the immunogenic function of the macrophages. (auth)

35670 VALUE OF RADIOINDUCED IMMUNOBIOLOGICAL CHANGES IN RENAL HOMOGRAFTS. De Serio, N.; Grimaldi, G. Quad. Radiol., 32: 1-21(Jan.-Feb. 1967). (In Italian).

Following a discussion of the role of ionizing radiation in overcoming the immunological barriers in renal homografts, an account is given of studies in renal transplantation in dogs. The spleen and pelvic regions of the dogs were irradiated before transplantation as was the kidney to be transplanted. The preoperative irradiation did not increase the survival period of the dogs over that of nonirradiated dogs, but histological studies performed during the survival period showed a smaller number of renal parenchymal lesions from an immunological origin in the irradiated homografts. (E.R.B.)

35671 SIGNIFICANCE OF IMMUNOASSAYABLE INSULIN IN URINE. Rubenstein, Arthur H. (Univ. of Chicago). J. Amer. Med. Ass., 209: 254-6(July 14, 1969).

Immunologic techniques which are widely used for the assay of plasma insulin can be applied, with minor modifications, to the measurement of urinary insulin. The clearance of insulin into urine (mean = 0.4 ml/min) is relatively constant over a wide range of plasma levels. Approximately 2% of the filtered insulin is excreted, amounting to 8,000 to 30,000 microunits per 24 hours in adults. The handling of insulin by the kidney is altered in acute or chronic renal disease, pregnancy, and hypertension. The measurement of urinary insulin has provided useful information in the study of neonates, insulin-requiring diabetics, and fasting subjects. (auth)

35672 DEGENERATION OF CARDIAC AND SKELETAL MUSCLE IN RADIATION CHIMERAS. Hulse, E. V.; Micklem, H. S. (Medical Research Council, Harwell, Eng.). Amer. J. Pathol., 55: 367-78(June 1969).

Severe and extensive granular degeneration of skeletal and cardiac muscle fibers occurred in x-irradiated mice given intravenous injections of allogeneic bone marrow cells plus allogeneic lymph node cells or spleen cells. Less pronounced lesions were found in irradiated mice given allogeneic marrow only. Rare and occasional lesions were seen in mice given irradiation alone or irradiation followed by syngeneic marrow cells. Histologically, the skeletal muscle lesions resembled some forms of myositis in man. The development of the lesions appears to be related to the presence of a graft-versus-host immune reaction. (auth)

35673 DOSAGE REQUIREMENTS FOR IMMUNOLOGICAL PARALYSIS BY SOLUBLE PROTEINS. Mitchison, N. A. (National Inst. for Medical Research, London). Immunology, 15: 509-30(Oct. 1968).

The quantitative dose requirements for induction of immune paralysis by bovine serum albumin (BSA), lysozyme, ovalbumin, diphtheria toxoid, and ribonuclease in mice were studied. The effects of ionizing radiation, cortisol, and thymectomy on the rate of induction of paralysis were also determined. The effect of irradiation upon the immune response to BSA challenged with the antigen in Freund's adjuvant at intervals after exposure to 600 R is shown. The minimum response (2.4% normal) was obtained 1 week after irradiation, and by 9 weeks recovery was well advanced (66% normal). Similar recoveries were obtained after exposure to 400 to 200 R, except that the response was less completely suppressed (19% minimum for 400 R; 21% for 200 R). On the basis of these data a standard period of treatment with antigen for 10 weeks was used in subsequent irradiation experiments. The schedule of paralysis can be chosen to provide a compromise between economy of labor and antigen: 600 R followed by 5 mg × 1/week was the optimum. A comparison with data obtained from nonirradiated mice showed that irradiation facilitated paralysis at intermediate doses of antigen, with the consequence that the threshold for paralysis was markedly reduced. On the other hand, no effect could be detected when the comparison was made in the low zone. The extent to which immunization was reduced by irradiation varied with the antigen. The ability of BSA to induce low-zone paralysis in normal adults was attributed to the failure of low doses of this antigen to immunize. The consistency of paralysis threshold, in contrast to the variability for immunization, was interpreted as evidence of an additional step of complexity involved in immunization that is not required for paralysis. (BBB)

35674 CELLULAR DIFFERENTIATION OF THE IMMUNE SYSTEM OF MICE. III. SEPARATE ANTIGEN-SENSITIVE UNITS FOR DIFFERENT TYPES OF ANTI-SHEEP IMMUNOCYTES FORMED BY MARROW-THYMUS CELL MIXTURES. Shearer, G. M.; Cudkowicz, G. (Roswell Park Memorial Inst., Buffalo). J. Exp. Med., 129: 935-51(May 1, 1969).

Marrow cell suspensions of unprimed donor mice were transplanted into x irradiated syngeneic hosts and 5 to 46 days later, bone cavities and spleens contained regenerated cells of the immune system which required interaction with thymocytes (from intact donors) and antigen (SRBC) to form antigen-sensitive units (ASU) and to generate mature immunocytes. These cells were capable of differentiating either into direct or indirect hemolytic plaque-forming cells (PFC). The precursors of PFC regenerated earlier than the other cell type necessary for immunocompetence, the antigen-reactive cell (ARC). The latter was not found until 10 or more days after transplantation. Availability of ARC was inferred from PFC responses elicited by grafted mice challenged with SRBC at varying intervals. In a second series of experiments, graded numbers of marrow cells (ranging from 10^7 to 5×10^7) were transplanted with 5×10^7 or 10^8 thymocytes into irradiated mice, and SRBC were given 18 hr later. After 9 to 12 days the recipient spleens contained all or some of the following immunocytes: direct and indirect PFC, and hemagglutinating cluster-forming cells. The frequency of each immune response varied independently of the others, but in relation to the number of marrow cells grafted. This was interpreted to indicate that ASU formed in irradiated mice by interaction of marrow and thymus cells were similar to those of intact mice. In particular, they were specialized for the molecular class (IgM of IgG) and function (lysis or agglutination) of the antibody to be secreted by their descendent immunocytes. Hence, class-differentiation appeared to be conferred upon ASU by their marrow-derived components. (auth)

35675 SYNTHESIS OF RADIOACTIVE TRICHINELLA SPIRALIS LARVAL ANTIGEN IN VITRO. Savel, Herbert; Kim, Charles W.; Hamilton, L. D. (Brookhaven National Lab., Upton, N. Y.). Exp. Parasitol., 24: 171-5(Apr. 1969).

A method for preparing radioactive Trichinella antigen by administration of both ^3H- and ^{14}C-labeled amino acids was developed. Greater protein incorporation was observed when 13 amino acids were present as compared with three amino acids. The radioactive protein was antigenic and specific; it stimulated transformation of lymphocytes from guinea pigs earlier sensitized to the homologous antigen and precipitated with anti-Trichinella serum. Filtration through Sephadex G-25 was used to separate the radioactive protein and amino acid fractions of the larval homogenate. Trichloroacetic acid precipitated 83% of the radioactivity of the pooled protein fractions. The final concentration of the pooled protein fractions was 0.55 μg/ml (^3H) and 0.88 μg/ml (^{14}C). This radioactively labeled antigen can be used in elucidating the mechanism of transfer of delayed hypersensitivity by lymphoid cells. (BBB)

35676 FURTHER STUDIES ON THE ROLE OF CIRCULATING LYMPHOCYTES IN THE INITIATION OF PRIMARY ANTIBODY RESPONSES TO DIFFERENT ANTIGENS. Strober, S.; Law, L. W. (National Cancer Inst., Bethesda, Md.). Proc. Nat. Acad. Sci. U. S., 62: 1023-30(Apr. 1969).

Thoracic duct cells obtained from normal (unimmunized) donors restored the primary hemolysin response of lethally whole-body x-irradiated or neonatally thymectomized rats to sheep red blood cells. Synergy between thoracic duct cells and bone-marrow cells was demonstrated in the irradiated hosts. However, thoracic duct cells did not restore the primary antibody response of irradiated rats challenged with diphtheria toxoid, but did restore the response of neonatally thymectomized rats. The addition of peritoneal exudate cells or bone-marrow cells to inocula of thoracic duct cells also failed to restore the response of irradiated hosts to diphtheria toxoid, although normal spleen cells restored the response. These findings indicate that the cellular events involved in the initiation of the primary antibody response to sheep red blood cells differ from those involved in the response to diphtheria toxoid. (auth)

35677 RADIATION STUDIES ON MICE OF AN INBRED TUMOR-RESISTANT STRAIN. VI. IMMUNE RESPONSES TO HETEROLOGOUS RED CELLS OF NONIRRADIATED AND IRRADIATED MICE. Stern, K. (Univ. of Illinois, Chicago); Goldfeder, A. Int. Arch. Allergy Appl. Immunol., 35: 504-13(1969).

Mice of the strain X/Gf showed a remarkable resistance to development of malignant tumors spontaneously as well as after x irradiation. Treatment with x irradiation and/or urethan induced leukemia or solid tumors in only 3 to 4% of the treated mice. Some other biologic properties of X/Gf mice were studied for clues on

the nature of their radioresistance. Immunologic reactivity of the mice was assayed by determination of natural agglutinins for sheep red cells and chicken red cells, and of agglutinins and hemolysins for sheep red cells after immunization with this antigen. Levels of natural agglutinins for chicken red cells and immune hemoantibodies for sheep red cells exceeded, or were equal to, those of comparable mice of strains C57BL/S and BALB/c/S which are known to exhibit good immune responses to heterologous red cells. Following total 300-R body x irradiation of X/Gf mice, transient depression of hemoantibodies occurred. The relative resistance of X/Gf mice to the carcinogenic effects of x irradiation and other agents may reflect the genetically determined potent immunologic reactivity and relative resistance of immune responses to irradiation, or their rapid recovery from this insult. (BBB)

35678 REGULATION OF ANTIBODY SYNTHESIS AGAINST ESCHERICHIA COLI ENDOTOXIN. IV. INDUCTION OF PARALYSIS IN VITRO BY TREATING NORMAL LYMPHOID CELLS WITH ANTIGEN. Britton, Sven (Karolinska Inst. Medical School, Stockholm). J. Exp. Med., 129: 469-82(Mar. 1, 1969).

Normal mouse lymphoid cells have been shown to become specifically paralyzed after in vitro exposure to high doses of detoxified endotoxin of Escherichia coli 055:B5. The immune status of the treated cells was tested after transfer to secondary x irradiated hosts. Paralysis was shown to be initiated by events taking place in vitro, since the amount of antigen retained on the cells after the in vitro exposure was insufficient to induce paralysis in vivo. The induction of paralysis was dependent on the concentration of antigen added to the cells in vitro. Certain variables, such as time of exposure and temperature at exposure, influenced the ease by which the cells could be paralyzed. Cells pretreated with trypsin were not susceptible to induction of paralysis by the above procedure. (auth)

35679 IMMUNOLOGICAL TOLERANCE IN VITRO: KINETIC STUDIES AT THE CELLULAR LEVEL. Diener, E.; Armstrong, W. D. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). Contract AT(20-1)-3695. J. Exp. Med., 129: 591-603 (Mar. 1, 1969).

When normal mouse spleen cells in suspension are cultured in vitro in the presence of polymer from Salmonella adelaide flagellin, an immune response can be obtained as measured at the level of single antibody-forming cells. Cultures were stimulated with different doses of antigen, ranging from 0.2 ng to 3 μg/ml of tissue culture fluid and it was found that the peak number of approximately 500 antibody-forming cells per 10^6 harvested cells by day four was antigen dose dependent, 2 to 20 ng/ml being the optimal concentration. When more than 1 μg/ml of polymer from S. adelaide together with either 20 ng/ml of polymer from S. waycross or with 4×10^6 sheep erythrocytes were placed in the system, unresponsiveness to S. adelaide, but immunity to the other antigens occurred simultaneously. Cells made immunologically tolerant in vitro to S. adelaide H antigens were transferred into syngeneic lethally x-irradiated recipients and challenged with the same antigen. The adoptive immune capacity in these mice, as measured at the level of the immunologically competent cell was reduced by 80 to 90% as compared with relevant controls. Attempts to induce low zone tolerance in vitro were without success. To study the kinetics of tolerance induction in vitro, cells were cultured with tolerogenic doses of antigen for various periods of time, washed, and subsequently cultured with immunogenic doses of antigen for four days. It was found that immunological tolerance may be induced to a significant degree in vitro within a period of 15 min. Similar results were obtained when spleen cells were exposed for various lengths of time to tolerogenic doses of antigen but at a temperature of 4°C instead of 37°C. The results are taken as suggestive evidence that the initial step in tolerance induction is related to the direct interaction between the surface of immune competent cells and antigen molecules. (auth)

35680 STUDIES ON IMMUNOLOGICAL UNRESPONSIVENESS DURING SECONDARY DISEASE. III. EFFECT OF DONOR STRAIN ON ACQUISITION OF MUTUAL TOLERANCE. Thompson, John S.; Simmons, Eric L.; Crawford, Margaret K.; Severson, Charles D. (Argonne Cancer Research Hospital, Chicago. Univ. of Chicago). Transplantation, 7: 447-58(June 1969).

A wasting disease that is associated with lymphopenia usually follows the successful transplantation of foreign hematopoietic tissues into lethally irradiated mice. Prevention of the appearance of this syndrome was attempted by injecting immunologically competent lymphoid cells 21 days after irradiation. When irradiated C3H mice were injected with H-2-incompatible C57BL/6 bone marrow, the addition of lymphoid cells 21 days later was never beneficial because a graft-versus-host reaction remained operative. However, when H-2-compatible AKR bone marrow was used to save the life of irradiated C3H mice, the late injection of large numbers of either host or donor lymphoid cells improved subsequent survival and prevented secondary disease. The experimental results using erythrocyte analysis, the discriminant spleen assay of Simonsen–Jensen, and studies on adoptive immunity to rat erythrocytes as a measure of graft-host interaction all suggest that mutual tolerance develops in C3H–AKR chimeras. This phenomenon appears to explain why added donor or host lymphoid cells were not rejected but instead improved the survival of immunologically incompetent hosts. Tolerance did not exist 48 hr postirradiation, since AKR spleen cells administered at this time killed the C3H–AKR hosts. However, passive immunization with donor antihost antisera 24 hr prior to spleen cell injection allowed some of the mice to survive without further evidence of wasting. Although other explanations are possible, these observations suggest that the acquired AKR–C3H tolerance found in these experiments 21 days postirradiation may have developed because of protective antibodies elaborated by both donor and host cells. (auth)

35681 STUDIES ON LYMPHOCYTES. XII. THE ROLE OF IMMUNOLOGICALLY COMMITTED LYMPHOCYTES IN REJECTING SKIN ALLOGRAFTS. Chanana, A. D.; Cronkite, E. P.; Joel, D. D.; Schiffer, L. M.; Schnappauf, H. (Brookhaven National Lab., Upton, N. Y.). Transplantation, 7: 459-67(June 1969).

Extracorporeal irradiation of thoracic duct lymph was carried out in calves for up to 68 days. Extracorporeal irradiation of thoracic duct lymph prolonged the survival of skin allografts in nearly all calves studied. In certain instances, however, skin allografts placed within the drainage bed of the thoracic duct survived significantly longer than skin allografts not within the drainage bed of the thoracic duct. The results from these experiments suggested that viable immunologically committed lymphocytes, involved in the first-set skin allograft rejection, enter the circulation via efferent lymph from the regional lymph nodes, and these cells could apparently be inactivated by extracorporeal irradiation of thoracic duct lymph. Lymphocytoxins failed to induce accelerated rejection of skin allografts in the absence of viable committed lymphocytes. (auth)

Ecology

Refer also to abstracts 35613, 35723, and 35934.

35682 (ORO-3299-20) EFFECTS OF IONIZING RADIATION ON PLANT SPECIES, POPULATIONS, AND ECOSYSTEMS. Progress Report, September 1, 1968–August 31, 1969. McCormick, J. Frank (North Carolina Univ., Chapel Hill). Contract AT(40-1)-3299. 28p. Dep. CFSTI.

The ecological effects of γ and β radiations were analyzed. Studies of species physiology, morphology, growth, and survival under defined conditions were utilized as baselines against which the effects of radiation and other environmental parameters were compared. One specific objective was to analyze the effects of ionizing radiation upon the physiological tolerances of plant species, and the reciprocal effects of physiological stresses upon species radiosensitivities. The effects of γ and β radiations on natural ecosystems that contain the same plant species selected for physiological studies in the laboratory were also analyzed. Results of the lab and field studies were compared in an attempt to derive logical hypotheses for ecosystem responses to combinations of radiation and other stresses. Comparisons were made of the radiosensitivities of major ecosystems of the Southeastern United States. From these comparisons one can predict the ecological effects of nuclear war. Comparisons were also made between the effects of γ and β radiation including exposure of communities to simulated fallout. The following projects show results and are described. The effects of γ radiation upon a pine forest; The cycling of radiostrontium in a pine forest; The effects of γ radiation upon a tropical rain forest; The influence of season upon the radiosensitivity of an old field community; The interactions of γ radiation and other environmental factors upon dominant species of the old field, tropical forest, and pine forest; The effects of β radiation upon island communities of the Southeastern granite outcrops; The factors that most strongly influence community structure; and estimates of photosynthesis, respiration, transpiration, production, carbon budgets, water budgets, and energy budgets for the entire ecosystem and for selected species were made. (E.R.B.)

35683 (SAN-226-4-X) ENIWETOK MARINE BIOLOGICAL LABORATORY. Annual Report, 1968–69. Hiatt, Robert W. (Hawaii Univ., Honolulu). May 1, 1969. Contract AT(29-2)-226. 30p. Dep. CFSTI.

Studies on systematics and zoogeography included taxonomy of nudibranchs, ecology and functional morphology of portunid crabs, ecology of spiders, electrophoretic studies of proteins from the lens of sharks, taxonomy of toxic fish, and taxonomy of chaetodont

fish. Studies on ecology included comparative ecology of Eniwetok species of the fish, Chromis (Pomacentridae), biology and ecology of three inshore sharks, biology of terebrid snails, population studies of infaunal and epifaunal marine amphipod crustaceans from sand substrata, ecology of crabs, ecology of seven species of ophiuroids (brittlestars), biology of the monitor lizard (Varanus indicus), field studies of rat populations, microbial biology of coral reefs, marine nitrifying and chemoautotrophic sulfur bacteria, microbiology of the lagoon and the surrounding ocean, studies on breeding terns, ecology and behavior of the coconut crab, Birgus latro, behavioral patterns and mimicry in blennies (fish), biology of giant clams (Tridacnidae), ecology of the house mouse (Mus musculus) and the rats, Rattus alexandricus and R. exulans, and ecology of the sea urchin, Echinometra. Studies on geology and hydrology included composition and permeability of reef structure, measurements of rise and fall of water level in small wells, permeability of Eniwetok reefs. Studies on physiology included production, perception, and reception of acoustical stimuli by the semi-terrestrial crab, Ocypoda ceratophthalma, and utilization of nutrient reserves in three marine invertebrates, a sea cucumber, a sea urchin, and a marine snail. Studies were conducted on identification of serum transferrins in rats from different islets for use as genetic markers in studies of population structure. Studies in general biology included analysis of stomach contents and toxicity of groupers and snappers, toxicity tests on bluegreen algae, and studies on anatomy, growth and metabolism of sharks. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 35184, 35590, 35666, 35723, 35731, 35851, 35931, 35940, 35941, and 35950.

35684 (ORAU-107, pp 81-4) INDUCTION OF SMALL-COLONY VARIANTS AND AUXOTROPHS OF CANDIDA ALBICANS BY ULTRAVIOLET LIGHT AND CHEMICAL MUTAGENS. Balish, Edward; Savage, Norman (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The biochemical basis for the morphogenesis and pathogenicity of Candida albicans was studied by isolation and characterization of sulfur amino acid auxotrophs. Chemical mutagens and uv radiation were used to produce small-colony variants (petites) and biochemical auxotrophs. A summary of results obtained with the chemical mutagens is presented in tabular form. Only three biochemical auxotrophs were isolated in 10 attempts with uv radiation; these results are also presented in tabular form. (C.O.)

35685 (ORAU-107, pp 102-5) THE EFFECT OF TOTAL-BODY IRRADIATION ON THE BONE-MARROW LYMPHOCYTES. Goh, Kong-oo (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Cytogenetic observations of the bone-marrow lymphocytes seven years after whole-body irradiation are reported. Chromosomal aberrations were found in the peripheral-blood leukocytes cultured with phytohemagglutinin; abnormalities were also found in the direct bone-marrow preparation of these subjects. These findings confirmed observations of others and suggested that chromosomal aberration effects were long lasting. (C.O.)

35686 JOINING OF CHROMOSOME FRAGMENTS AT EARLY STAGES AFTER X RAY IRRADIATION. Generalova, M. V. (Inst. of Developmental Biology, Moscow). Dokl. Akad. Nauk SSSR, 184: 211-3(Jan. 1, 1969). (In Russian).

An analysis of chromosome rearrangements in metaphase in the first few hours after irradiation was carried out on the roots of Crepis capillaris. The material was fixed 2, 3, and 4 hours after irradiation with an x ray dose of 150 R. The maximum frequency of aberrations (21.8%) was observed 3 hours after irradiation, although maximum adhesion or clumping of the chromosomes was observed 2 hours after irradiation. Clumping was rarely observed 4 hours after irradiation. The aberration frequency levels out at four hours after the irradiation. Thus changes taking place in the early stages after irradiation can be correlated to explain the chromosome damage caused by irradiation. (TTT)

35687 GENETIC REPAIR PHENOMENA AND DOSE-RATE EFFECTS IN ANIMALS. Sobels, F. H. (Univ., Leiden). Advan. Biol. Med. Phys., 12: 341-52(1968).

Studies in radiation genetics during the past decade have revealed that mutations are not irreversibly fixed at the time of radiation exposure; instead it has become increasingly clear that, depending on the organism and the metabolic conditions of the irradiated cells, the initial damage is reversible and can be repaired for some time following irradiation. The pertinent data that were obtained on repair phenomena and dose-rate effects in animals are reviewed with emphasis on recent findings in the mouse and in Drosophila. (E.R.B.)

35688 LOSS OF HOST-CONTROLLED RESTRICTION AND MODIFICATION OF PHAGE λ IN ESCHERICHIA COLI K12 PREVIOUSLY INFECTED WITH UV-IRRADIATED COLIPHAGE T3. Grasso, Robert J.; Paigen, Kenneth (Roswell Park Memorial Inst., Buffalo). Virology, 38: 191-4(May 1969).

Bacteriophage λ propagated in Escherichia coli C (λ.C) differ from the progeny of the same phage propagated in E. coli K12 (λ.K). When these phages are assayed on E. coli K12, λ.C produces only one plaque for every 1000 produced by λ.K. This prevention of replication of most λ.C particles by E. coli K12 is termed host-controlled restriction and the conferment of K12-host specificity on phage λ is termed modification. The occasional plaques that arise when λ.C infects E. coli K12 result from the presence of a few special cells that have lost their ability to restrict λ.C, but still maintain their ability to modify infecting λ.C producing λ.K progeny. In order to explore the requirement of the K12-restriction enzyme for S-adenoylmethionine (SAM), E. coli K12 was infected with uv-irradiated T3 (uv-T3) prior to superinfection with λ.C. The restriction was impaired and the progeny phage did not acquire K12-host specificity. Phage uv-T3 is capable of inducing an enzyme that cleaves SAM. Similar, prior infection with uv-irradiated T7, that is incapable of inducing SAM cleavage enzyme, had no effect on restriction. Infection of K12 with uv-T3 prior to superinfection with λ.K revealed that the majority of the cells retained their ability to confer K12 specificity or replicated DNA. Modification ability was lost only in those cells that also lost their ability to restrict. The few special cells normally present in K12 populations that support λ.C replication differ from uv-T3 infected cells in their ability to modify infecting λ.C. (M.W.B.)

35689 INTRACELLULAR DEVELOPMENT OF BACTERIOPHAGE φX174 INACTIVATED BY γ-RAY, ULTRAVIOLET LIGHT, OR NITROUS ACID. Lytle, C. David; Ginoza, William (Pennsylvania State Univ., University Park). Virology, 38: 152-65(May 1969).

An investigation was conducted to determine how far along the infectious cycle a dead φX174-phage can proceed within its host cell, using γ rays, light, or nitrous acid (HNO_2) as inactivating agents. The DNA is the primary target for inactivation by these agents. The inactivation sensitivities were determined for the abilities of the treated phage to attach to the host bacterium, to inject DNA into its host, to form replicative-form (RF) molecules, to prevent transcription and/or replication of untreated phage, to prevent colony formation of the host bacterium, and to complement genetic functions. It was found that, for each means of inactivation, all these abilities were affected except adsorption. In each case some inactivated phage could inject DNA that was then made into RF or RF-like structures. Some uv- and HNO_2-inactivated phage can kill the host bacterium. Only uv-damaged phase can compete with untreated phage for transcription and/or replication or can complement genetic functions. In the latter case less than one-fifth of the inactivated phage gave protein as measured by complementation. Sublethal effects of HNO_2 treatment were manifested in the complementation experiment. The probability of a dead phage reaching each of the known sequential steps in development decreases in order. The uv-inactivated phage demonstrated the greatest proficiency at reaching any of the steps preceding transcription. The results indicate that the abilities to compete with untreated phage and to kill the host are expressed after RF formation but before transcription/translation. The possible role of a functional bacterial site is discussed. It is theoretically possible that the primary cause of inactivation is the loss of unique genetic information. However, these experiments indicate the actual biological mechanism for most of the inactivation by these agents is prevention of intracellular development preceding expression of phage-coded functions. (auth)

35690 AUTONOMOUS REPLICATION OF A DEFECTIVE TRANSDUCING PHAGE IN PSEUDOMONAS PUTIDA. Chakrabarty, A. M.; Gunsalus, I. C. (Univ. of Illinois, Urbana). Virology, 38: 92-104(May 1969).

The mandelate gene cluster for four enzymes was transduced from Pseudomonas putida strain PRS1 (ATCC 12633) to the camphor-growing, mandelate-deleted strain PUG2 (ATCC 17452). Whereas crosses within strain PRS1 using phage pf16h2 yield principally phage-sensitive transductants, the interstrain crosses of PRS1 and PUG2 yield mostly immune ones, unstable for the mandelate and immune characters. The mandelate cluster is segregated at an approximate frequency of 10^{-3} per bacterium per division during the cellular life cycle of the transductants. The immune heterogenotic transductants do not produce active vegetative phages on induction, but upon uv irradiation and superinfection with viable nontransducing phages they produce lysates that transduce at frequencies of 10^{-5} to 10^{-6} instead of the usual 3×10^{-8}. The release of transducing phages is dependent on the multiplicity of the superinfecting phages and on the dose of uv-irradiation. Phage-sensitive transductants of PUG2 also occur,

and these also produce high-frequency transducing lysates without producing viable phages. It is concluded that the transducing particles consist of different amounts of the phage genome, with or without an immunity-controlling region, and lack some essential phage function. These defective phages were termed pfdm in analogy to λdg or Pldl. In CsCl gradient the infective particles in high-frequency transducing lysates have a characteristic density of 1.519 g/cm^3, whereas three of the pfdm elements tested vary in density from 1.526 to 1.534 g/cm^3, suggesting compositional heterogeneity of the transducing particles. Phage-sensitive transductants of PUG strains can be cured of the defective pfdm particles by uv irradiation. They contain a satellite DNA band in addition to the bacterial DNA in a CsCl density gradient. These cells overproduce mandelate enzymes suggesting that pfdm particles replicate autonomously in the phage-sensitive PUG cells. (auth)

35691 RADIOBIOLOGICAL INVESTIGATIONS ON PTERIS VITTATA L. I. X-RAY INDUCED PLASTID VARIATIONS IN THE GAMETOPHYTES. Mehra, P. N.; Palta, Harinder, K. (Punjab Univ., Chandigarh, India). Radiat. Bot., 9: 93-103 (Mar. 1969).

X irradiation of dry dormant spores of Pteris vittata L. with 25,200, 50,400, 75,600, 100,800, 126,000 R exposure, and wet germinated spores with 1088, 2176, 3264, 4352, 5440, 6528, 7616 and 8704 R produced gametophytes with various plastid abnormalities. Out of 124 cultures (each culture with about 6000 spores), 84 such gametophytes were isolated and twelve distinct plastid types were established. For some types plastid change was found to be permanent in the gametophytic phase of the life cycle. Many types underwent reversion, however, giving rise to chimeral gametophytes. The probable mechanism underlying this is discussed. More work is in progress to determine if the plastid variations can be transferred to the succeeding sporophytic and the subsequent gametophytic generations. (auth) (UK)

35692 CHANGES IN CHROMOSOME STRUCTURE INDUCED BY RADIATIONS: A TEST OF THE TWO CHEIF HYPOTHESES. Heddle, J. A.; Whissell, D.; Bodycote, D. J. (Univ. of California, San Francisco). Nature (London), 211: 1158-60(Mar. 22, 1969).

Two hypotheses have been advanced to suggest how radiation may produce chromosome aberrations. The first hypothesis, due to Sax (Genetics, 23: 494(1938)), is known as the "breakage first" hypothesis and postulates that the initial lesion is a chromosome break. The two ends produced may (a) rejoin in the original configuration (restitution), or (b) rejoin "illegitimately" with other ends produced by another break to form an exchange, or (c) may remain unjoined to form a terminal deletion. The second hypothesis, due to Revell (Mutation Res., 3: 34(1966)), postulates that all chromatid aberrations are exchanges produced by the interaction of two lesions (not breaks). Aberrations involving only one chromosome are produced only at the point of overlap, where the chromosome is looped back on itself. Attempts to distinguish between these two hypotheses have centered on the relative frequencies of the different kinds of aberrations and on dose response relationships, and results have been equivocal. A more direct test of the differences between the two hypotheses is reported. It was shown that many terminal deletions are in fact incomplete exchanges, and the data obtained agree with Revell's exchange hypothesis. Studies were made using cultures of Potorous tridactylis (rat kangaroo), and pulse labeling by tritiated thymidine was employed. After 44 hr, when the cells were expected to be approaching the second mitosis after labeling, the cultures were irradiated with 300 kVp X-rays at 100 R/min to total doses of 25, 50, or 100 R. Cells were subsequently scored for terminal deletions. Autoradiograms were later made and the presence or absence of an exchange was recorded. The findings are discussed in detail. The overall frequency of exchanges associated with terminal deletions was 38%, in close agreement with the 40% predicted by Revell's exchange hypothesis, and clearly different from the prediction of ~8% of the "breakage first" hypothesis. It is concluded that the most reasonable hypothesis is that chromatid deletions are a mixture of unrejoined single breaks and incomplete exchanges between sister chromatids. (UK)

35693 DEPENDENCE OF THE NUMBER OF CHROMOSOME ABERRATIONS IN HUMAN LYMPHOCYTES IRRADIATED IN VITRO UPON THE TIME OF CULTIVATION WITH PHYTOHAEMAGGLUTININ. de la Vega, R.; Mikhelson, V. M. (National Center of Scientific Investigations of Cuba, Havana. Inst. of Cytology, Leningrad). Tsitologiya, 11: 600-3(May 1969). (In Russian).

Human peripheral lymphocytes were x-irradiated in vitro using doses of 50 to 150 R (14.3 R/min) and cultivated with phytohemagglutinin (PHA) for 48 or 72 hr. Forty-eight and 72 hr cultivations resulted in a frequency of chromosome breaks per cell equal to 0.0044 and 0.0027, respectively. A decrease of chromosome breaks value after a 72 hr incubation may be due to the fact that a significant part of dividing cells are found in the second mitosis and a great number of chromosome aberrations may have been eliminated by this time. This suggests that for purposes of investigation of radiation damage of human lymphocyte chromosomes, and especially of its postradiation recovery, the use of 48-hr cultures seems much preferable rather than universally adopted 72-hr cultures. (auth)

35694 SPACE-FLIGHT ENHANCEMENT OF IRRADIATION EFFECTS IN THE FLOUR BEETLE, TRIBOLIUM CONFUSUM. Slater, John V.; Buckhold, B.; Tobias, C. A. (Univ. of California, Berkeley). Radiat. Res., 39: 68-81(July 1969).

Space environment combined with x or γ radiation on Biosatellite II for 42 hr significantly enhanced two radiation effects in the developing flour beetle, Tribolium confusum. A developmental wing abnormality, appearing in adults following pupal irradiation, was increased to 44.8% in flight, compared with control incidence of 29.9%. Similarly, dominant lethals of offspring of females irradiated in space increased significantly to 78% from 27% on the ground. Postflight ground control tests indicate that weightlessness, not acceleration or vibration, was the contributing factor. The duration of the pupal stage was unaffected. All pupae were between 19 and 27 hr old at launch and were preirradiated with 1350 R of 180-keV x rays to place them into their sensitive dose range. Total irradiation received in space, from a ^{85}Sr γ-ray source, was approximately 950 R. (auth)

35695 IDENTIFICATION OF CLOSELY LINKED LOCI CONTROLLING ULTRAVIOLET SENSITIVITY AND REFRACTIVITY TO COLICIN E2 IN ESCHERICHIA COLI. Holland, I. B.; Threlfall, E. J. (Univ. of Leicester, Eng.). J. Bacteriol., 97: 91-6 (Jan. 1969).

Mutants (phenotypic symbol Ref-II) refractory to colicin E2 were isolated in several strains of Escherichia coli K-12, and a ref II locus was mapped 1 to 2 min counter clockwise to thr. A small number of Ref-II mutants are also ultraviolet (uv)-sensitive and the uv^s locus in one such strain was mapped close to the ref II locus near thr. The Ref-II mutation alone does not affect recombinant formation in F$^-$ strains, but the Ref-II, uv^s strains behave in many respects like Rec$^-$ mutants, giving reduced recombination frequencies in crosses with male strains. It is suggested that the ref II and uv^s loci correspond to closely linked if not identical genes, concerned in some way in the activity of one or more deoxyribonucleases, and that the Ref-II, uv^s mutants arise as the pleiotropic expression of a single gene or of a deletion or polar mutation affecting linked genes. (auth)

35696 EFFECT OF DEOXYURIDINE-MONOPHOSPHATE ON THE RADIATION-INDUCED MUTATION RATE. Magdon, E.; Winterfeld, G. (Institut fuer Krebsforschung, Berlin). Arch. Geschwulstforsch., 32: 207-14(1968). (In German).

Using adult male Drosophila melanogaster of the Berlin wild strain, the effect of deoxyuridine-monophosphate (dUMP) on the radiation induced rate of recessive sexlinked lethal factors was investigated in different stages of spermatogenesis. It was shown that the mutation rate induced by irradiation with 1500 R was significantly increased in spermatogonies. dUMP was not effective in spermatozoa. A possible explanation seems to be that only in DNA synthetizing germ cells the change in the precursor pool by dUMP caused to a significant increase of the radiation-induced mutation rate. (auth)

35697 FURTHER INVESTIGATIONS ON THE ANTIGENIC STRUCTURE OF PROTEUS MIRABILIS. III. CHEMICAL COMPOSITION OF POLYSACCHARIDES FROM R-MUTANTS. Gromska, W.; Radziejewska, J.; Sidorczyk, Z.; Zwolinski, J. Bull. Acad. Pol. Sci., Ser. Sci. Biol., 17: 19-22(1969).

For a study of the chemical composition of the R-polysaccharide of Proteus, R-mutant strains were isolated after the mutagenic action of 2537 Å uv radiation and nitrosoguanidine in sublethal doses. Isolation of stable R-mutants of Proteus mirabilis (strain 1959) proved to be difficult. Because of the swarming growth of this species, 0.1% phenol agar plates were used to obtain colony growth of the mixture of S- and R-forms after the action of the mutagenic agents. Primary selection of the presumed colonies according to the known criteria concerning their morphology and the type of growth on fluid media was almost impossible. Most rough colonies did not exhibit typical appearance even when they did not agglutinate in O serum and revealed agglutinability in various electrolyte solutions. The presumed R-colonies consisted of nonmotile bacteria and remained nonmotile in subcultures on agar broth. However, most of the isolated mutants showed, after months of subculture, a weak ability to agglutinate in O serum, suggesting a progressing selection of smooth forms. The composition of polysaccharides extracted from R forms revealed decreased galactosamine and uronic acid content. (BBB)

35698 DIFFERENCES IN THE FREQUENCY OF THE VARIOUS MONOSOMIC TYPES IN NATURAL AND X-IRRADIATED POPULATIONS OF OATS, AVENA SATIVA L. Ekingen, Halis R. (Univ., Goettingen, Ger.). Z. Pflantzenzuecht., 61: 63-90(1969). (In German).

Most of the oat monosomic types studied have been selected either from untreated natural populations or after x irradiation. By mutagenic x-ray treatment the spontaneous rate of monosomics can be increased from 0.5 or 1% to about 15%. Together with the induced loss of single chromosomes, other genetic disturbances are also produced by x-ray treatment. Whether the selection of monosomics from untreated populations, despite lower yield, has any advantage over the technique using x irradiation was studied. In untreated populations of the Borreck and Zenshin varieties, all plants deviating phenotypically were selected. By such preselection, the occurrence of spontaneous monosomics in the Borreck variety was raised from below 1% to 2.37% and in the Zenshin variety to 2.53%. The 20 monosomics obtained this way were compared with the 32 monosomic lines of the Borreck variety, which were obtained after x-ray treatment. From the radiation experiments the monosomic chromosome could be identified in 26 lines. Altogether, 18 of these lines were deficient in a long chromosome, 4 (or 5) in a medium, and only 3 in a shorter one. The shortest chromosome of the complement (21) was present in all lines, while the longest chromosome (3) was lost 5 times. This distribution indicates that longer chromosomes, because of their larger target volume, are more radiosensitive than shorter ones. No confirmation was obtained that heterobrachial chromosomes are more radiosensitive and therefore more liable to be lost after irradiation than isobrachial ones. Of the 26 lines investigated, 19.2% were monosomic in 1 of the 7 subterminal chromosomes, but the 4 median chromosomes were monosomic in 34.6% of the cases. The shortest chromosome (21), which was present in all the x-ray induced lines, was monosomic in 3 of the lines from untreated populations. For the establishment of the complete set of the 21 monosomics in oats, the 2 selection procedures complement each other, and should be used simultaneously. The fertility of the oat monosomics was reduced, but the degree of sterility varied greatly with environmental conditions. Fertility of monosomics produced by x irradiation was generally lower than that of the spontaneous monosomics, even where the same chromosome was affected. This indicates cryptic genetic changes as a consequence of irradiation. (BBB)

35699 TEMPERATURE-SENSITIVE MUTANTS OF ASCOBOLUS IMMERSUS. Yu-sun, Clare C. C. (California Inst. of Tech., Pasadena). Amer. J. Bot., 56: 341-3(Mar. 1969).

Temperature-sensitive mutants (ts) were isolated following uv irradiation of ascospores of strain W-64 (white-spore mutant). The uv-treated spores were plated on peptone agar and incubated overnight at 37°C. Colonies showing restricted growth were then isolated and tested. The 23 ts mutants could be grouped on the basis of their growth responses at 3 temperatures, 25, 30, and 37°C. The first three, ts 1, col ts 79, and cot 17, were alike in that they were incapable of growth at 37°C, but they differed in their responses at 25 and 30°C. The first grew normally at both temperatures, the second expressed a colonial phenotype at both temperatures, while growth of the third was normal at 25°C but colonial at 30°C. The biochemical changes responsible for the temperature sensitivity of the Ascobolus mutants are not known. Since they all grow equally well on minimal and complete medium at 25°C but on neither at 37°C, it is possible that at the higher temperature they would require a complex molecule which cannot be incorporated from the medium. (BBB)

35700 PROTEIN SYNTHESIS BY A MUTANT OF PHAGE S13 BLOCKED IN DNA SYNTHESIS. Shleser, Robert; Tessman, Ethel S.; Casaday, George (Purdue Univ., Lafayette, Ind.). Virology, 38: 166-73(May 1969).

Gene IV amber mutants of phage S13 are known to be blocked in synthesis of progeny replicative form DNA (RF). Protein synthesis by a gene IV mutant was studied in a nonpermissive host cell strain that permits phage particle formation by the standard phage at doses of uv radiation that severely depress host protein synthesis. Using gel electrophoresis analysis, it was found that the mutant formed normal amounts of all the six major protein peaks that are observed for the standard phage. (Three of the gel peaks correspond to protein-coat components). Thus the block in DNA synthesis caused by the gene IV mutation does not switch off either transcription or translation of the majority of the phage genes. Furthermore, parental RF alone is sufficient to produce normal amounts of phage-specific protein. (auth)

Health Physics and Safety

Refer also to abstract 35457.

35701 FUNCTION OF MEDICAL PHYSICISTS IN THE FIELD OF NUCLEAR MEDICINE. Wolf, Rudolf (Univ., Mainz). Roentgenpraxis, 22: 25-8(Feb. 1969). (In German).

The functions of medical physicists in the field of nuclear medicine are summarized. Medical physicists must be familiar with the methods of radiation measurements; they must have some knowledge of physiology and anatomy, electronics and dosimetry, and data processing. The medical physicists have a special role in the planning of new research facilities. A thorough knowledge of all nuclear therapeutic and diagnostic methods is essential. Scintigraphic methods are the special responsibility of the medical physicists. (J.S.R.)

Radioactive Contamination and Decontamination

Refer also to abstracts 35010, 35613, 35616, 35617, 35732, 35739, and 35920.

35702 (A-AC-82/G/L-1280) ^{90}Sr LEVELS OF FALLOUT AND OF FOOD DIET IN U.A.R. DURING THE YEAR 1968. Mahmoud, K. A.; Meloukhia, M. K.; Abdel-Latif, S. A.; Ahmed, M. W.; El-Shinawy, A. M. (Atomic Energy Establishment, Inshas (Egypt)). Mar. 1969. 11p. Dep.

Quarterly levels of ^{90}Sr in fallout deposition as well as levels of total α, β, and γ radioactivities of daily air filter samples at different stations in the United Arab Republic (U.A.R.) are reported for the year 1968. Moreover, 1968 ^{90}Sr levels of mixed cooked meals and estimated daily intakes of ^{90}Sr and stable Ca were also reported for certain Cities and certain Provinces of U.A.R. that were found by comparison to represent the major dietary habits all over the Country. This report is a continuation of several reports of U.A.R.S.C.E.A.R. that started since 1956. (auth)

35703 (A-AC-82/G/L-1281) LEVELS OF POTASSIUM AND ^{137}Cs IN MAN IN U.A.R. DURING YEAR 1968. Morsy, S. M.; Abu-Bakr, M. Y. (Atomic Energy Establishment, Inshas (Egypt)). Apr. 1969. 5p. Dep. CFSTI.

Whole-body counting was used to measure the ^{137}Cs and ^{40}K contents of in 30 human adults residing in the United Arab Republic during 1968. Data on ^{40}K content were used to calculate the whole-body K content. (C.H.)

35704 (CEA-CONF-1283) EXPERIMENTAL DATA DESIGNED FOR THE ESTIMATION OF CONTAMINATION OF THE NUTRITIOUS PORTION SINCE THE TIME OF TRANSFER OF CESIUM AND OF STRONTIUM THROUGH THE PLANT AND AS FAR AS AN EDIBLE PRODUCT. Bovard, P.; Delmas, J.; Disdier, R.; Grauby, A. (Commissariat a l'Energie Atomique, [Cadarache] (France). Centre d'Etudes Nucleaires). [1969]. 16p. (In French). (SM-117/12; CONF-690317-1). Dep.

From Seminar on Agricultural and Public Health Aspects of Environmental Contamination by Radioactive Materials, Vienna, Austria.

Contamination of food products depends not only on soil plant factors but also on methods of technology. It was shown that contamination of three cultures by radioactive waste was influenced by laboratory conditions. The quantity of ^{90}Sr absorbed by tomatoes from seven different contaminated soils varied in a relation of 1 to 2.4, that of rice, 1 to 2. For radiostrontium, the mechanical process of transformation applied to rice caused the activity to diminish 4.6 to 1. The combined action of crushing and heat doubled the contamination of tomato concentrate. Maceration and pressure caused the contamination of red and rosé wine to vary from 3 to 1. These data show that food technology plays a role in estimation of the dose received by the population. In case of accidental contamination such results can serve as a reliable guide. (tr-auth)

35705 (HASL-210) FALLOUT PROGRAM. Quarterly Summary Report, March 1-June 1, 1969. Hardy, Edward P. Jr.; Rivera, Joseph (New York Operations Office (AEC), N. Y. Health and Safety Lab.). July 1, 1969. 232p. Dep. CFSTI.

Current data from the HASL Fallout Program, the National Radiation Laboratory in New Zealand, the EURATOM Joint Nuclear Research Centre at Ispra, Italy, the Radiological Physics Division at Argonne National Laboratory, and the Argentine Atomic Energy Commission are presented. The initial section consists of interpretive reports and notes covering the following topics: worldwide deposition of ^{90}Sr through 1968, ^{90}Sr levels in the diets and bones of Argentine children, stratospheric inventories for 1967 to 1969, and ^{90}Sr in human vertebrae specimens collected in 1968. Subsequent sections include tabulations of radionuclide levels in stratospheric air, surface air, fallout, milk, other diet components, and tap water. A bibliography of recent publications related to radionuclide studies is also presented. (auth)

35706 (HASL-210(App.)) FALLOUT PROGRAM. Quarterly Summary Report, March 1-June 1, 1969. [Hardy, Edward P. Jr.;

Rivera, Joseph] (New York Operations Office (AEC), N. Y. Health and Safety Lab.). July 1, 1969. 384p. Dep. CFSTI.

This appendix to the Health and Safety Laboratory Fallout Program quarterly summary report for March through June 1969, contains data on the following programs: ^{90}Sr and ^{89}Sr in monthly deposition at world land sites; radiostrontium deposition at Atlantic Ocean weather stations; radionuclides in monthly surface air samples; and radiostrontium in milk and tap water. A table of conversion factors and a table of radionuclides are included. All data are presented in tabular form. (E.R.B.)

35707 (ORNL-TM-2513) SECOND QUARTERLY PROGRESS REPORT ON THE THEORETICAL EVALUATION OF CONSUMER PRODUCTS FROM PROJECT GASBUGGY. Kelly, M. J.; Rohwer, P. S.; Jacobs, D. G. (Oak Ridge National Lab., Tenn.); Bowman, C. R. (El Paso Natural Gas Co., Tex.). Mar. 1969. Contract W-7405-eng-26. 27p. Dep. CFSTI.

A hypothetical radiation exposure situation was created for the non-processed-gas users (farm taps, etc.) located between the Gasbuggy site and the gas-processing plant at Blanco. It was assumed that trunk L was reconnected at the point of the physical cut which presently exists and that the Gasbuggy well was connected to the gas-gathering system. The pipeline dilution factors and the hypothetical dwellings described are used in a preliminary evaluation of one of the potential exposure situations — the radiation dose commitment resulting from inhalation of tritiated water vapor (HTO) present in the combustion products of a home-heating system burning tritium-contaminated gas. (J.C.W.)

35708 STUDIES ON REMOVAL OF RADIOACTIVE CONTAMINATION IN BODY. 3. Kawaguchi, Hiroshi (Nara Medical Univ., Japan). Nara Igaku Zasshi, 19: 450-7(Sept. 1968). (In Japanese).

The calcium trapping effect of orally administered phytin in the digestive tract was studied in rats. This effect appeared to be the result of the ion-exchange reaction between the phytin molecule and the digestive juice calcium in the acidic medium found mainly in the stomach and duodenum. It is suggested that if the elimination of calcium from bone to the blood plasma is accelerated by the injection of EDTA or by any other treatments, the excretion of radiocalcium or radiostrontium in feces will be increased by the use of phytin. The diet containing 1.5% of phytin may be effective for the removal of radioactive contamination with ^{45}Ca or ^{90}Sr in rats. (auth) (NSAJ)

35709 DEKORPORIERUNG RADIOAKTIVER UND STABILER METALLIONEN. THERAPEUTISCHE GRUNDLAGEN. (Decorporation of Radioactive and Stable Metal Ions. Therapeutic Principles). Catsch, Alexander. Munich, Verlag Karl Thiemig KG, 1968. 82p. DM 32,-.

This monograph deals with a relatively young and very specialized section of experimental and clinical medicine: the mobilization of potentially dangerous radionuclides from the organism of mammals including humans. The goal is the development of therapeutic measures in cases of "radioactive poisoning" based on chemical and biological principles as well as the analysis of data yielded by animal experiments. The lack of thorough clinical experience is caused by the small number of accidents involving incorporation of radioactive material. This fact justifies detailed presentation of experimental facts as well as more theoretical aspects. The publication emphasizes radioactive metals; however, the basic principles as well as the practical conclusions can be applied to the therapy of poisoning by nonradioactive metals. This book is of interest in the following fields: radiation protection, internal medicine, nuclear medicine, radiology, radiobiology, pharmacology, and biochemistry. (tr-auth)

35710 ^{137}Cs BODY BURDENS IN FLORIDA RESIDENTS. Roessler, G. S.; Dunavant, B. G.; Roessler, C. E. (Univ. of Florida, Gainesville). Health Phys., 16: 673-9(June 1969).

Measurement of ^{137}Cs body burdens in nearly 300 persons with the University of Florida whole-body counter from 1965 to date shows that Florida residents had levels of ^{137}Cs two to three times as high as those reported elsewhere in the conterminous United States during the same time period. Analysis of the data by year shows that the levels did not drop with time as rapidly as levels reported in other areas of the United States. Cesium-137 levels in Florida residents averaged 0.395, 0.353, and 0.318 nCi/kg lean body mass in 1965, 1966, and 1967, respectively. For the entire 1965 to 1967 period these levels averaged 0.350 and had a range of 0.044 to 1.667 nCi/kg lean body mass. In contrast, non-Florida residents measured at the same facility had an average of 0.151 nCi/kg lean body mass. Reproducibility of the measurements was within 10%. These levels correlate with the reported levels of ^{137}Cs in Florida-produced foods, which in general are much higher than the average for the United States. (auth) (UK)

35711 EFFECTIVE DOSE OF DTPA, SPACED AT 3 DAY INTERVALS, IN REMOVAL OF SKELETAL PLUTONIUM. Rosenthal, M. W.; Russell, J. J.; Moretti, E. S.; Lindenbaum, A. (Argonne National Lab., Ill.). Health Phys., 16: 806-8(June 1969).

The study described was designed to determine the minimal effective dose of DTPA (diethylenetriamine-pentaacetic acid), given once every third day, for removal of plutonium deposited in the bone of mice. This information, based on tissue measurements, rather than excretion data, should prove useful for both clinical applications and experimental studies in which DTPA therapy is used over long periods. (auth) (UK)

35712 INVESTIGATIONS OF UNUSUAL CESIUM ECOLOGY IN FLORIDA: ^{137}Cs LEVELS IN FEED-LOT BEEF. Roessler, C. E.; Dunavant, B. G.; Bevis, H. A. (Univ. of Florida, Gainesville). Health Phys., 16: 691-700(June 1969).

Florida beef was sampled during May 1966, and the first half of 1967, and analyzed for ^{137}Cs to help define the unusual radioecological situation first suggested by radionuclide levels observed in Florida milk. Cesium-137 levels in grain-fed beef showed a geographic trend, with the highest levels, 110 to 540 pCi/kg, occurring in the southern and south-central parts of the State and the lowest levels, 55 to 175 pCi/kg, occurring in the northwestern part. Levels in beef showed the same general geographic pattern shown by levels in milk. These findings and the results reported for Florida milk and dairy feeds indicate that this nuclide is concentrated to higher levels in biological materials in much of Florida than would be predicted from the distribution and levels of fallout deposition and from the average concentration by these media in other parts of the country. (auth) (UK)

35713 STUDIES CONCERNING THE EFFECT OF FERRIC FERROCYANIDE, BEET PULP, AND FLUORIDE UPON ^{137}Cs RETENTION IN THE RAT. Wolsieffer, John R.; Stookey, George K.; Muhler, Joseph C. (Indiana Univ., Indianapolis). Proc. Soc. Exp. Biol. Med., 130: 953-6(Mar. 1969).

The individual and additive effects upon the elimination of ^{137}Cs from the body of supplementation of the diet with 1% ferric ferrocyanide (Prussian blue), 20% beet pulp, and 0.007% sodium fluoride was determined in rat muscle, femur, and carcass 30 days following a single intraperitoneal injection of the isotope. Ferric ferrocyanide showed a significant effect in reducing ^{137}Cs retention in each of the examined tissues. Beet pulp showed a significant effect in reducing ^{137}Cs retention in muscle tissue when used separately, and a greater effect when used in combination with ferric ferrocyanide and fluoride. Fluoride significantly reduced ^{137}Cs retention in the femur when used separately. The combination of all dietary regimens resulted in the removal of 98.7 and 97.0% of the ^{137}Cs in muscle and femur, respectively, and in the complete elimination of ^{137}Cs from the remaining carcass of the rat. (auth)

35714 CONTAMINATION OF POTATOES THROUGH DIPPING IN ^{90}Sr OR ^{137}Cs SOLUTIONS. Paulus, K. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch., 135: 126-32(1967). (In German).

Radioisotope uptake by peeled, unpeeled, and chipped potatoes was studied after immersion in solutions of strontium-90 and cesium-137. The rate of uptake depends on the radioisotope and the condition of the potato. Under identical experimental conditions a rate constant can be determined that is characteristic for each radioisotope. (H.B.G.)

35715 DECONTAMINATION OF GRAIN. PART I. Pelshenke, P. F.; Ocker, H.-D.; Bolling, H.; Zwingelberg, H. Getreide Mehl, 17: 77-80(July 1967). (In German).

Strontium-90 contamination in grain can be removed only to a small degree by conventional methods of dry cleaning or by several minutes washing in tap water. The effect can be improved to a maximum of 75% by the addition of chelating agents, polyphosphates, organic acids, and other materials to the water, and by extension of the washing time to several hours. These procedures remove predominantly superficially located contamination but hardly affect the core of the grain. Therefore, they are applicable for whole wheat flour intended for animal feed, but not for purified white flour. (H.B.G.)

35716 DECONTAMINATION OF MEDICAL INSTRUMENTS WITH A DETERGENT SOLUTION IN VIBRATOR. Zlatanov, St. Voenno Med. Delo., 25: No. 1, 39-44(1969). (In Bulgarian).

Medical instruments and equipment may be contaminated by radioactive isotopes under field conditions in connection with the use of nuclear weapons. Good results were obtained in the USSR by decontaminating objects from radioactive isotopes in a vibra-

tor operating at sonic frequencies and that was filled with a detergent solution. This method was tested in stainless steel plates, plexiglas, and rubber that had been contaminated with ^{32}P, ^{131}I, and ^{89}Sr. Simulated medical instruments and equipment requiring decontamination were also tested. Treatment in a vibrator with sonic frequency in the presence of a solution of the Bulgarian detergent Sinpro proved effective. The best results were obtained when the detergent solution was acidified with a small amount of HCl; a temperature of 40°C was applied, and treatment was continued for 1 hr. The vibrator can be easily used under field conditions if electric current is available. (JPRS)

35717 ^{137}Cs AND ^{90}Sr IN BLOOD AND URINE OF LAPPS AND SOUTHERN FINNS COMPARED WITH THE TOTAL BODY BURDEN OF ^{137}Cs AND THE ESTIMATED DIETARY INTAKE OF ^{90}Sr. Jaakkola, Timo; Miettinen, J. K.; Haesaenen, Erkki; Romantschuk, Hakan (Univ. of Helsinki). Radiochim. Acta, 11: 214-16(1969).

Cesium-137 and ^{90}Sr were determined in samples of blood and urine of two populations, reindeer herding Lapps in 1966 and southern Finns, in 1964. The results are compared to the respective whole-body levels of ^{137}Cs in the same subjects and with the calculated dietary intakes of ^{90}Sr and Ca in the same populations in 1961. (auth)

35718 VERXITE FLAKES FOR IN VIVO BINDING OF ^{134}Cs IN COWS. Hazzard, D. G.; Withrow, T. J.; Bruckner, B. H. (Public Health Service, Rockville, Md.). J. Dairy Sci., 52: 995-7(July 1969).

Sixteen Holstein cows, averaging 23 ± 6 kg milk per day, were used in a single-factor design consisting of four treatment levels and four replicates, to study the effectiveness of verxite flakes for in vivo binding of ^{134}Cs. Verxite was incorporated into the morning grain ration at levels of 0.82, 0.54, 0.27, or 0 kg per day per cow. Each cow received 0.2 μCi of ^{134}Cs daily in the afternoon grain ration. There were no statistically significant differences observed in milk concentration of Na, K, Ca, or Mg as a result of verxite feeding. However, marked differences were noted in milk ^{134}Cs levels. Compared to the nonverxite group, the average percent reductions of ^{134}Cs in the secreted milk of the verxite-treated groups were 88, 84, and 68, respectively, for the 0.82, 0.54, and 0.27 kg daily verxite intakes. These results indicate that feeding verxite flakes in sufficient quantity could serve as an effective means of reducing radioactive Cs levels in milk. (auth)

35719 PERCENT ^{134}Cs AND ^{85}Sr IN MILK, URINE, AND FECES OF GOATS ON NORMAL AND VERXITE-CONTAINING DIETS. Hazzard, D. G. (Public Health Service, Rockville, Md.). J. Dairy Sci., 52: 990-4(July 1969).

Four goats of predominantly Toggenburg breeding were used in a cross-over design to study the effects of vermiculite (verxite flakes) on the binding of ^{85}Sr and ^{134}Cs. Vermiculite was incorporated into the grain ration at a level of 10% of the grain ration (approximately 3% of total ration) of one-half of the animals. Each morning either ^{85}Sr or ^{134}Cs was administered separately in gelatin capsules per os at an approximate level of 0.6 μCi per day to the respective animals. Milk samples were collected twice daily while total collections of urine and feces were made on a 24-hr basis. Portions of all samples were counted using a gamma scintillation spectrometer. The vermiculite-treated animals receiving ^{134}Cs had a more rapid rate of radioisotope excretion than did the nontreated animals, the percentages of the total body clearance of ^{134}Cs which occurred during the five-day dosing period being 83 and 62%, respectively. Excretion and secretion data were compared between animals receiving and not receiving vermiculite. These data, expressed as percentages of the daily ingested doses of ^{134}Cs, were respectively, for milk 0.3 versus 2.3; for urine 1.7 versus 11.2; and for feces 64.6 versus 26.6. There were no consistent differences between the treated and nontreated animals receiving ^{85}Sr. (auth)

35720 EFFECT OF POTASSIUM PERCHLORATE AND SOIDUM CHLORIDE GIVEN ORALLY UPON RADIOIODINE DEPOSITION INTO MILK OF GOATS. Cline, T. R.; Plumlee, M. P.; Christian, J. E.; Kessler, W. V. (Purdue Univ., Lafayette, Ind.). J. Dairy Sci., 52: 1124-6(July 1969).

Studies were conducted to determine the optimal oral dose of potassium perchlorate required by goats to minimize the radioiodine content of milk after a single ^{131}I injection, and to determine the effects of oral dosing of $KClO_4$ or sodium chloride, or both, upon ^{131}I deposition into milk during multiple dosing of radioactivity. The data indicate that 1.0 g of $KClO_4$ per head per day was adequate to substantially reduce the level of radioiodine in milk and that $KClO_4$ had the same relative protective effect against the iodine transfer into milk, whether it was given as a single dose or in multiple doses. Sodium chloride given orally had no effect on the iodine transfer into milk in these studies. (auth)

35721 INVESTIGATION OF THE INFLUENCE AND VALUE OF SOME CHEMICAL SUBSTANCES IN THE THERAPY OF CONTAMINATED PERSONS. Vojvodic, Spasoje; Stojadinovic, Svetan. Bull. Boris Kidric Inst. Nucl. Sci., 19: Biol., No. 4, 27-30(Nov. 1968).

The therapeutic effect of ferric cyanoferrate in the case of single oral contamination with radioactive cesium-137 has been investigated as a function of time after contamination. For this purpose rats were given ferric cyanoferrate at different time intervals after contamination. The results have shown that this substance is most efficient if given immediately after oral contamination. The efficiency of ferric cyanoferrate progressively decreases with prolonged time of its application in relation to the time of contamination. Administration of this substance 24 hrs after contamination does not have any effect. (auth)

Dosimetry and Monitoring

Refer also to abstracts 35013, 35023, 35473, 35474, 35488, 35528, 35702, 35705, 35706, 35797, and 37058.

35722 (AECL-3112) ANALYSIS OF PERSONAL RADIATION EXPOSURES IN 1968. Rowe, P. C.; Cowper, G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1969. 11p. Dep. CFSTI. CAN $0.50.

An analysis of occupational radiation exposures received by personnel at AECL sites in 1968 was carried out by machine accounting methods. Results are presented in tables and graphs for whole-body external β and γ radiation and whole-body internal β dose from tritium ingestion. (C.H.)

35723 (AECL-3199) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, JULY 1 TO SEPTEMBER 30, 1968. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1968. 39p. (PR-B-79). Dep. CFSTI. CAN $1.00.

Research in progress at the Chalk River (Ontario) facility of Atomic Energy of Canada Limited is reported by the Biology and Health Physics Division. Current research projects in the Biology Branch are included in the following areas: Biochemistry and Molecular Biology; Cellular and Whole Animal Physiology; and Genetics, Development and Population Studies. The Environment Research Branch is currently engaged in off-site, effluent, and stack monitoring and numerous research projects on the movement of radioisotopes and radioactive materials in the environment in relation to hydrological and radiological parameters. The Health Physics Branch is engaged in the design, construction, and performance of instruments for the detection, dosimetry, and monitoring of radioactivity. Results of routine β- and γ-monitoring of personnel are reported by this branch. Lists of staff members and current publications are also given by each branch. (E.R.B.)

35724 (CEA-CONF-1282) APPROACH TO THE PROBLEM POSED BY THE EVALUATION OF LEVELS OF RADIOACTIVE CONTAMINATION OF AMBIENT AIR AND OF THE ALIMENTARY CHAIN. Lacourly, G.; Garnier, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1969]. 29p. (In French). (CONF-690317-3). Dep.

From Seminar on Agricultural and Public Health Aspects of Environmental Contamination by Radioactive Materials, Vienna, Austria.

The importance of establishing limits for radiation doses to the population from contaminated atmosphere and food is discussed. Equations expressing the radiation dose from ingestion of contaminated food by individuals of a homogeneous population are given. Studies on variability of transfer parameters for ingestion of ^{90}Sr in Friesland, Hessen, and Basilicata were conducted, and tables showing ^{90}Sr contamination of various age groups from cereals, potatoes, vegetables, fruits, meat, fish, eggs, milk, and cheese are presented. Studies on comparison of diet regimes showed that variations in the $^{90}Sr/Ca$ ratio were on the order of 1.3 to 1.7. (H.L.W.)

35725 (MORP-68-11(Rev.)) DENTAL SURPAK SUMMARY REPORT. (Bureau of Radiological Health, Rockville, Md.). Apr. 1968; Revised Mar. 1969. 11p. CFSTI.

The results of the Dental Surpak Program conducted by the Bureau of Radiological Health are summarized for the years 1960 to 1966. Nine tables of data are presented from the results of more than 52,000 machines surveyed by the Surpak method, and these tables report beam size and symmetry, Roentgen output, pointer cone by type and length, and radiation leakage. (auth)

35726 (NP-17935) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND RESULTS OF EXTENDED MONITORING OF FALLOUT FROM FRENCH NUCLEAR TESTS IN THE PACIFIC, Annual Summary, 1968. (National Radiation Lab., Christchurch (New Zealand)). 44p. (NRL-F-33). Dep.

A summary of the 1968 radiological surveillance activities in New Zealand and the South Pacific is presented. The following data are presented in the summary: the fission products content of air and rain given as total β activity during 1966 through 1968; the ^{90}Sr content of rain in New Zealand and the South Pacific during 1959 through 1968; the ^{90}Sr content of soils in New Zealand during 1953 to 1968; the ^{90}Sr content of milk in New Zealand during 1960 through 1968; and the ^{137}Cs content of milk during 1963 through 1968. Surveillance activities in the South Pacific are conducted to determine the effects of nuclear testing. Results include total β radioactivity from fission products in air filter and rainwater samples during 1966 to 1968 over the South Pacific and New Zealand, the ^{89}Sr and ^{90}Sr content of rainwater during the same time, and the ^{131}I content of milk and cattle thyroid during the same period. Special surveys and miscellaneous measurements include: monthly average ^{137}Cs content of milk in New Zealand during 1968, ^{137}Cs to ^{90}Sr ratio in milk during 1963 through 1968, the ^{210}Pb content of rain in South Pacific and New Zealand during 1967 through 1968, and the ^{90}Sr, ^{226}Ra, and ^{210}Pb content of human bones in relation to annual rainfall rates during 1961 through 1966. (E.R.B.)

35727 (ORAU-107, pp 39-42) PATIENT DOSIMETRY FOR THE LOW-EXPOSURE-RATE TOTAL-BODY IRRADIATOR. Beck, W. L.; Cloutier, Roger J.; Comas, Frank V.; Lushbaugh, C. C.; Stokes, Tom R. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Depth-dose distribution in the mid-longitudinal and mid-sagittal planes as measured in a phantom irradiated in the low-exposure rate whole-body ^{60}Co γ-irradiation facility are presented. The phantom and lithium fluoride dosimeters used in the study are discussed. Surface exposure values were determined using patients and the phantom. Average target organ doses calculated from complete depth-dose distribution measurements are tabulated. (C.O.)

35728 (ORAU-107, pp 151-5) QUANTITATIVE MEASUREMENT OF RADIOACTIVITY IN INTERNAL ORGANS BY AREA SCANNING. Arimizu, Noboru; Morris, A. C. Jr. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Whether area scanning to visualize the configuration of organs and tumors by a frequency distribution of dots or counts on a scan record could be used for assaying the activity in internal organs was investigated. More than 850 scans were performed to ascertain how the integrated area counts of scans varied with radioisotope geometry. Five radioisotopes were used: ^{85}Sr, ^{68}Ga, ^{131}I, ^{113m}In, and ^{99m}Tc. Data are presented in graphic and tabular form. It was concluded that with access to a double-headed scanner and a computer, this method offered the advantage of producing quantitative organ-uptake measurements along with diagnostic area scanning records. (C.O.)

35729 (ORAU-107, pp 248-51) IMPROVEMENT IN ACCURACY OF WHOLE-BODY RADIOISOTOPE QUANTITATION BY THE SCATTER-WINDOW METHOD. Gibbs, W. D.; Hodges, Harold D.; Queener, R. F.; Lushbaugh, C. C. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

A method for accurate relative or absolute quantitation of the radioactive content of humans is described; it is based on the assumption that for every radioisotope a window exists in which the variation in observed counts per minute per unit radioactivity is minimum with changes in source location or distribution. A humanoid water phantom containing a point source in 33 different locations was used in the whole-body counter. Optimal windows for ^{198}Au, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{59}Fe, ^{131}I, ^{54}Mn and ^{65}Zn versus γ-ray energy are illustrated in graphic form. The intersection of the threshold and window top lines at 100 keV indicated that for γ rays of energy less than about 100 keV the optimal scatter window concept could not be used. The method at present was restricted to single radioisotope retention studies since optimum windows for one isotope may overlap the photopeak of another. (C.O.)

35730 (ORNL-tr-2157) DISPERSION OF A RADIOACTIVE CLOUD AND THE DOSES TO BE EXPECTED FOR THE TOTAL POPULATION. Bayer, A. (Kernforschungszentrum, Karlsruhe (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report KFK-868. 39p. Dep. CFSTI.

Using the Sutton dispersion formula and the meteorological parameters of Blässer-Wirtz, the population dispersion factors for the total population were determined for normal and inversion weather conditions with the assumption of point-shaped, constant, and concentrated population densities (urban areas). The considerations extended up to source distances of 100 km with a study of stack heights of H = 0 m, 50 m, and 100 m. Using the example of a given emission hazard produced by ^{131}I, some population doses that were to be expected were determined. Finally, the expected population doses and the maximum expected individual doses were related to the proposed tolerance doses from the aspect of source distance. (auth)

35731 (UCSF-10-P-2-80) RADIATION-INDUCED CHROMOSOME ABERRATIONS IN MAN: A POSSIBLE BIOLOGICAL DOSIMETER. Heddle, John A. (California Univ., San Francisco. Lab. of Radiobiology). May 1969. 14p. Dep. CFSTI.

The human lymphocyte is useful as a biological dosimeter in determining whether or not an individual has received a significant radiation dose. It may be possible to make reasonable estimates in the dose range of 50 to 500 rads by adhering strictly to standard procedures. Nevertheless, a good test has not been made in the important dose range, and there are many unknown factors that could affect the estimate. Work is currently in progress in several laboratories, so we may expect resolution of some of the problems in the next few years, including an evaluation of the usefulness of the estimate. Furthermore, estimates of the sensitivity of human chromosomes from lymphocyte data are unlikely to be much better than order-of-magnitude estimates, and extrapolation to the important meiotic cells is very risky. (auth)

35732 A CONTRIBUTION TO THE STUDY ON THE TWENTY-FOUR HOURS AND ON THE DAILY RUN OF THE NATURAL BETA RADIOACTIVITY OF ATMOSPHERIC AEROSOLS IN PLOVDIV. Ivanova, D.; Stefanova, M.; Genkov, D. (Higher Medical Inst., Plovdiv, Bulgaria). Folia. Med. (Plovdiv), 9: 24-9(1967).

The 24 hr and the daily run of the natural β radioactivity was studied using the filter method. The filters were changed every four hr, and in such a way six tests were obtained for every 24 hr. The correlation between the 24 hr and daily run and the meteorological elements (temperature, moisture, and wind velocity) was followed up. For Plovdiv, the 24 hr run was represented by a curve with a minimum between 1 and 5 p.m. and a maximum between 1 and 5 a.m. (auth)

35733 STUDY OF THE DISTRIBUTION OF THE DOSE AROUND THE UTERO-VAGINAL APPLICATOR OF OGIER-SCARPA, USING ELECTRONIC METHODS OF CALCULATION. Renzi, R.; Maurenzig, P. R. (Univ., Florence). Nunt. Radiol., 33: 349-67(Apr. 1967). (In Italian).

Using electronic methods of calculation, the distribution of the intensity of dose around the utero-vaginal applicator of Ogier-Scarpa was determined. The importance of a detailed knowledge of this distribution and some of the obtained results are discussed. (auth)

35734 PHOTOGRAPHIC DOSIMETRY: DOSE DISTRIBUTION IN COBALT TELETHERAPY OF THE LARYNX. Olivares, M. P.; Urbina, R.; Perez-Modrego, Y. S. Acta Oncol., 6: 105-9 (Jan.-June 1967). (In Spanish).

Telecobalt therapy generally requires a careful scheme and an exact centering, especially where the field area is small. The problem of centering, making reference to larynx tumors that, being generally of small size, are treated with small fields as well is discussed. The results obtained in dose distribution studies are compared between treatments correctly performed, with or without a wedge-filter, and others where centering mistakes were made through progressive deplacement of the irradiation beam in either a converging or parallel sense, according to the cases. The method utilized to determine the value of any desired isodose by means of photographic densitometry is exhibited, and a graph is presented where the values of optical density are found, to be subtracted in each case from the value of the latter at the point considered to be a hundred per cent. (auth)

35735 ENDOTHERMIC PROCESSES IN TISSUE-EQUIVALENT PLASTIC. Fleming, D. M.; Glass, W. A. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res., 37: 316-22(Feb. 1969).

The use of tissue-equivalent plastic as the absorbing element for absolute calorimetric measurement of dose is limited by uncertainties existing in the heat lost by endothermic processes induced in the plastic by the absorbed radiation. Measurements have been conducted to determine experimentally the difference between the absorbed energy and the resulting thermal energy, a thermal defect, for Shonka-type tissue-equivalent plastic when irradiated by monoenergetic protons. Results of this work indicate that the thermal defect varies with total absorbed dose and is nearly twice as great as has been predicted for a similar plastic on the basis of independently determined G values. An extrapolated zero-dose value for the thermal defect was found to be $4.17 \pm 0.2\%$. The thermal defect decreases with accumulated absorbed dose and appears to reach a saturation value of 3.67% for doses above 10^9 rads. (auth)

35736 DATA ON WATER. Radiol. Health Data Rep., 10: 258-64(June 1969).

Averages of the monthly total β and γ radioactivity in the Columbia River are reported for samples obtained during July 1967 to June 1968. The total β radioactivity of other surface waters in the state of Washington (excluding the Columbia River)

are also presented for the same period. The tritium sampling network reports the tritium content of samples from major river systems in United States during July to December, 1968. (E.R.B.)

35737 DATA ON AIR AND DEPOSITION. Radiol. Health Data Rep., 10: 265-70(June 1969).

Data from the surveillance activities of the Radiation Alert Network, the Canadian Air and Precipitation Monitoring Program, and the Pan American Air Sampling Program are presented in tabular and graphic forms. The gross β radioactivity in surface air and precipitation in the United States during February 1969 is presented, and monthly and yearly profiles of β radioactivity in surface air at selected stations in the United States during 1963 to 1969 are also given. Gross β radioactivity levels in surface air and precipitation in Canada are given for February 1969, as are the gross β radioactivity levels in Pan American surface air during the same period. (E.R.B.)

35738 OTHER DATA. Radiol. Health Data Rep., 10: 271-9(June 1969).

The content of ^{137}Cs, ^{89}Sr, and ^{90}Sr in muscles and the ^{137}Cs content of the rumen of Alaskan caribou and reindeer are given for samples analyzed during September through November 1968. A comparison is made of the ^{137}Cs content of caribou and reindeer in Alaska between Fall values during 1967 and 1968. All data are presented in tabular form. The report on environmental levels of radioactivity at Atomic Energy Commission Installations includes: long-lived gross α and β radioactivity of particulates in air in the Oak Ridge area, the content of ^{131}I and ^{90}Sr in raw milk from the Oak Ridge area, the gross β radioactivity and the content of ^{89}Sr, ^{137}Cs, ^{144}Ce, ^{106}Ru, ^{60}Co, ^{95}Zr, and ^{95}Nb in the Clinch River, and the average dose rate (mR/hr) from external γ radiation in the Oak Ridge area. The gross α radioactivity in airborne particulates and water supplies in the environs of the Rocky Flats Plant in Colorado is also presented. Data on the Oak Ridge area were collected during January to June, 1968, while the data on the Rocky Flats area were collected during July to December, 1968. The U.S.A.E.C. announced two nuclear tests at the Nevada Test Site during May 1969 and recorded seismic signals from the Soviet nuclear test area on May 16 and May 31, 1969. (E.R.B.)

35739 DATA ON MILK AND FOOD. Radiol. Health Data Rep., 10: 247-57(June 1969).

Data are presented in tabular form on the results of milk surveillance activities in Canada, United States, and Central and South America. The concentrations of ^{137}Cs, ^{131}I, and ^{90}Sr in milk samples taken during February 1969 and average concentrations of these radionuclides in milk samples taken during March 1968 through February 1969 are given. (E.R.B.)

35740 METHODS OF CALCULATION IN STUDIES ON RADIOPROTECTION. Hillion, P. (Laboratoire Central de l'Armement, Arcueil, France). Radioprotection, 3: 227-40(1968). (In French).

The problem of calculations in studies of radioprotection is discussed, and it is shown that the problem is reduced to a search for solutions of the Boltzmann equation. Three numerical methods for the solution of this equation are discussed. The region of validity of each method and the precision of the results are emphasized. (tr-auth)

35741 STUDY OF KIDNEY IRRADIATION IN THE COURSE OF SCANNING WITH NEOHYDRIN ^{197}Hg. Pavel, Dan; Ionita-Teodorasco, Lidia (Centre de Gastroenterologie, Bucharest). J. Radiol., Electro., Med. Nucl., 50: 43-6(Jan.-Feb. 1969). (In French).

Measurements of the radiation dose to human kidneys during scanning using mercury-197-labeled chlormerodrin showed that the dose absorbed by the kidney was 33.5 rads when one μc of labeled chlormerodrin was administered. The presence of ^{203}Hg contamination added approximately seven rads to the radiation dose absorbed by the kidney. (C.H.)

35742 ENERGY DEPOSITION IN MICROSCOPIC VOLUMES BY HIGH-ENERGY PROTONS. Hilbert, Jerald W.; Baily, Norman A. (Emory Univ., Atlanta). Radiat. Res., 39: 1-14(July 1969).

Measurements of the frequency distributions of the energy deposited as the result of the passage of high-energy protons through microscopic volumes of biological interest present some unique problems. A method is described that permits the determination of such distributions in arbitrarily shaped volumes having dimensions equivalent to fractions of a micron of unit-density tissue. The method is illustrated for a 1.77-micron-diameter tissue sphere, irradiated with 40 MeV protons, and implications to other energies and geometries are made in terms of the generalizations possible from these results. Distributions for various depths in a tissue-like phantom are also presented. (auth)

35743 ON THE EQUIVALENCE OF TWO MODELS FOR THE BLOOD DOSE CALCULATION IN EXTRACORPOREAL IRRADIATION TECHNIQUES. Karlsson, Bengt R. (National Inst. of Radiation Protection, Stockholm). Radiat. Res., 39: 112-16(July 1969).

It was shown that two proposed models for the calculation of the blood dose in extracorporeal irradiation techniques gave identical predictions. This fact was not realized earlier, owing to an inconsistency in the analysis of one of the models. The interpretation of one of the characteristic concepts of the models, the transit time, is also discussed. (auth)

35744 IN-PHANTOM DOSIMETRY OF RADIOISOTOPIC HEAT SOURCES. Cross, F. T. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 48(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35745 COSMIC-RAY-INDUCED RADIOACTIVITY IN ASTRONAUTS AS A MEASURE OF RADIATION DOSE. Brodzinski, R. L.; Wogman, N. A.; Perkins, R. W. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 394-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35746 AN INVESTIGATION OF THE FIELDS OF GAMMA-RADIATION FROM GRID AND WEDGE-LIKE FILTERS WITH THE AID OF A MINIATURE TRANSISTORIZED Si(Li)-DETECTOR. Devyatykh, Yu. N.; Meshcheryakov, A. B.; Morozov, A. I.; Petushkov, A. A.; Ustinskov, V. I. (Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 14: No. 2, 46-8(Feb. 1969). (In Russian).

A miniature transistorized lithium-drifted silicon detector was used to obtain information concerning the fields and distribution of gamma doses from grid and wedge filters in small volumes of air and tissue-equivalent phantoms. (auth)

35747 NOTE ON THE RELATION BETWEEN ABSORBED DOSE, KERMA, ENERGY FLUENCE, AND EXPOSURE. Eisenlohr, H. H. (International Atomic Energy Agency, Vienna). Health Phys., 17: 335-6(Aug. 1969).

In many practical cases absorbed dose is not measured directly but is calculated from the amount of ionization produced in air by the radiation. The assumed relationship connecting the absorbed dose in air with exposure implies that the exposure may be understood as ionization equivalent in air of the absorbed dose in the case of small volume and under conditions of electronic equilibrium. Considering the case where the actual specific ionization in a finite volume differs from the exposure by an applied bremsstrahlung correction, the exposure is no longer strictly the ionization equivalent of absorbed dose. This correction, however, will in general be small. Equations are given connecting absorbed dose with energy fluence and with exposure, for a finite volume. It is suggested that exposure is not the proper parameter if it is wished to determine absorbed dose by measuring the ionization in a finite volume. It is commonly stated that beyond the dose buildup region (region of transient equilibrium) in a material the absorbed dose slightly exceeds kerma, since the dose is delivered by secondary electrons originating in a region closer to the radiation source, where the primary γ-rays are less attenuated. Escape of bremsstrahlung energy will have the opposite effect. A 4% decrease of dose will occur in air for 10 MeV γ-radiation because of bremsstrahlung losses. (UK)

35748 DATA ON MILK AND FOOD. Radiol. Health Data Rep., 10: 197-211(May 1969).

Data from milk surveillance activities during January 1969 are reported by the Pasteurized Milk Network, Pan American Milk Sampling Program, and Canadian Milk network. In addition to the monthly average concentration of ^{137}Cs, ^{131}I, and ^{90}Sr in milk, 12-month averages are presented for the year February 1968 through January 1969. Samples were obtained from selected stations throughout Canada, USA, and Central and South America. Food and diet surveillance activities in California are reported in the form of estimated daily intake of ^{141}Ce, ^{144}Ce, ^{137}Cs, ^{54}Mn, ^{226}Ra, ^{89}Sr, ^{90}Sr, and ^{95}Zr (pCi/capita/day) during November 1967 through September 1968. All data on milk and food surveillance activities are presented in tabular form. (E.R.B.)

35749 DATA ON WATER. Radiol. Health Data Rep., 10: 212-15(May 1969).

The North Carolina State Board of Health in maintaining its water surveillance activities collected and presents the following data: the gross α and β radioactivity in raw and treated surface

waters used as sources of public water supplies; the gross β radioactivity in ground waters; and the gross α and β radioactivity in cistern water. All samples were obtained during 1967 from selected sites throughout the state and the data are presented in tabular form as pCi/liter. (E.R.B.)

35750 DATA ON AIR AND DEPOSITION. Radiol. Health Data Rep., 10: 216-22(May 1969).

Surveillance activities of the Radiation Alert Network, Canadian Air and Precipitation Monitoring Program, and Pan American Air Sampling Program are reported for January 1969. The data include: gross β radioactivity in surface air and precipitation in the United States and Canada, and gross β radioactivity in surface air in Central and South America. All data were obtained from selected sampling sites and are presented in tabular form. (E.R.B.)

35751 OTHER DATA. Radiol. Health Data Rep., 10: 223-34(May 1969).

Offsite surveillance activities around the Nevada Test Site are reported for January to June 1965. The data include: net γ radioactivity levels from offsite ground monitoring stations, gross β radioactivity levels and ^{131}I and ^{133}I content of air samples, and ^{131}I content of milk samples from offsite areas. As a part of the continuing surveillance activities at AEC installations throughout the United States, the following data are presented: the α and β radioactivity levels in air samples, the non-volatile α and β radioactivity levels in Sawmill Creek water, the uranium, plutonium, and thorium isotopes content of Sawmill Creek water, the non-volatile α and β radioactivity levels in Des Plaines and Illinois River, and the ^{137}Cs and ^{90}Sr fission products content of milk samples. All data were collected during January through June 1968 in the vicinity of Argonne National Laboratory. Results of milk, sewage effluent, and surface water monitoring activities in the environs of the Nuclear Devices Department in St. Petersburg, Florida are given for July through December 1967. The content of ^{238}Pu, ^{210}Po, and tritium in the atmosphere and in offsite surface waters during January through June 1968 are reported by Mound Laboratory. The USAEC announces two underground nuclear tests at the Nevada Test Site during April 1969. (E.R.B.)

35752 DOSIMETRY DURING INCORPORATION OF RADIOACTIVE MATERIAL. PART I. Puppe, D. (Strahleninstitut des Staedt. Krankenhauses Spandau, Berlin). Roentgenpraxis, 22: 29-40(Feb. 1969). (In German).

Dose determination during external irradiation or in intracavity irradiation with open radioactive materials can be made on the basis of measurements. Dose determinations from the incorporation of radioactive materials must, however, be calculated. The methods, questions, and problems concerned with these calculations are given. The principles for the calculation of the energy dose are outlined. The calculation of the energy absorption of photon radiation is shown. (J.S.R.)

35753 CALCULATION AND DEMONSTRATION OF PERCENTAGE DEEP DOSAGE IN TELECURIETHERAPY WITH THE AID OF THE COMPUTER MINSK 22. Holan, J.; Knor, V. (Komenskeho Univ., Bratislava). Bratislav. Lek. Listy, 50: 751-7 (May 1968). (In Czech).

Based on the present methods of calculation and visualization of percentage depth dose in static telecobaltotherapy with ^{60}Co, a modification of the shape of the function g (Di, ρ), for the doses at the central axis is described. Deviation of this function from tabular values measured on a suitable phantom were less than 1%. The results achieved with the computer Minsk 22, relative to speed, accuracy, and expenses of calculations, entirely satisfy the clinical requirements. (auth)

35754 PHYSICIANS EXPOSURE TO RADIATION IN X-RAY EXAMINATION. Perttala, Y.; Rytilae, A. Duodecim, 84: 1119-23(1968). (In Finnish).

The exposure doses to which the examining physician is subjected were measured by fluoroglasses during 100 contrast medium studies of the gastrointestinal tract, 50 urethrocystographies on male patients, and 100 lower extremity venographies. The maximum doses were measured on the forehead, the forearms, and the shoulders. The dose of radiation accumulated in the forehead in a single contrast medium study of the gastrointestinal tract was 0.1 mR, 29 mR in urethrocystography, and 10 mR in venography. (auth)

35755 RADIUM VS ^{137}Cs IN THE TREATMENT OF SKIN CANCER: A COMPARATIVE STUDY OF THEIR DOSE-RATES AND EFFECTS. Wooldridge, Wilfred E.; Lorenc, Ernest (Univ. of Missouri, Springfield). S. Med. J., 62: 563-6(May 1969).

The determination of γ-radiation levels at various distances in various media was made with a capsule containing 25 mg of Ra and one with ^{137}Cs equivalent to 25 mg of Ra. The experimental data indicated that the dose rate of ^{137}Cs is only slightly less than that of Ra up to distances of 15 cm from the source when measured in air, water, plastic, and small thicknesses of lead. It was concluded that this offers only a slight advantage in protection. Following these determinations, the comparative biologic effects of Ra and ^{137}Cs needles of equivalent potency were tested by implanting them into the subcutaneous tissues of rabbits. After gross and microscopic comparison of the areas treated by Ra and ^{137}Cs, it was was not possible to distinguish any difference at the epidermal, dermal, or subcutaneous levels. Cesium-137 requires less shielding for storage than Ra. Radium needles of modern construction are quite safe with proper handling and the possibility of rupture from a build-up of internal pressure is negligible. (BBB)

35756 DOSE, TIME, AND FRACTIONATION: A CLINICAL HYPOTHESIS. Ellis, Frank (Churchill Hospital, Oxford). Clin. Radiol., 20: 1-7(Jan. 1969).

Based on published clinical results of radiotherapy, a formula is suggested that relates total dose, number of fractions, and overall treatment time to a quantity termed Nominal Standard Dose. This quantity represents the biological effect of a given treatment regime. Using this concept it is possible to compare various treatment schedules that involve different fractionation patterns and various overall treatment times. The evidence upon which the idea is based, and also its use in routine clinical practice are discussed. (auth)

Radiation Protection

Refer also to abstracts 35466, 35467, 35796, 35804, and 35917.

35757 (ORNL tr-2152) PRIMARY LITERATURE IN THE FIELD OF RADIATION PROTECTION. Scheel, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Translated for Oak Ridge National Lab., Tenn., from report SZS-17/68. 29p. Dep. CFSTI.

Citation data obtained from two volumes of Health Physics and Giornale di Fisica Sanitaria e Protezione Contro le Radiazioni were used to survey the literature in the field of radiation protection. The results showed that: nearly 60% of all citations were derived from journals; about 20% of all cited journals contained 75% of journal citations; journals of medicine and biology were most frequently cited; most of the cited journals were published in the U.S.A.; about 50% of all citations were not older than 5 and about 80% not older than 10 years; and there are two components of literature, the classic and the ephemeral. (auth)

35758 SPECIALIZED IRRADIATION TECHNIQUES IN THE USE OF HIGH-ENERGY ELECTRONS IN OPHTHALMOLOGY. Lommatzsch, P.; Seidel, W.; Fuerst, G. (Humboldt-Univ., Berlin). Klin. Monatsbl. Augenheilk., 150: 45-50(1967). (In German).

Direct and indirect methods were reported for shielding the eyeball from high-energy electrons of 3 to 15.5 MeV energy. Isodose distributions in the eye using a Pb shield 4.3 mm thick, with a dia of 28 mm, showed that the 20% contour was located in the eyeball, and was due to bremsstrahlung. In the immediate vicinity of the eyeball the dose was increased. The 80% isodose contour extended up to 3 cm depth. A more uniformly constructed shield made of Pb or W was no more effective. An indirect method of shielding with a tube was described for cases where various tumor growths required treatment with high energy electrons. The most sensitive portion of the eye was located within the 10% isodose contour, and a relatively high symmetrical therapeutic dose was obtained up to a depth of 3 cm in the eyeball. The direct and indirect methods of shielding were essentially equally effective, but the indirect method was more comfortable for the patient. High-energy electrons were most effective for tumors at depths up to 2 or 3 cm, such as for extensive muriform eyelid or epibulbar tumors. Additional, lateral x-ray irradiation was required for deeper, retrobulbarly located tumors. (BBB)

35759 RADIOPROTECTION OF LETHALLY IRRADIATED MICE WITH 2-HYDROXYMETHYL-THIOPHENE. Falconi, C.; Porta, E.; De Rosa, G.; Gaetani, B.; Pisciotta, R. (Univ., Naples). Radiobiol. Radioter. Fis. Med., 23: 393-9(Nov.-Dec. 1968). (In Italian).

The radioprotective effects of 2-hydroxymethyl-thiophen on mice irradiated with lethal doses of x rays are reported. From the different survival observed with equal doses of the same solution, injected at different intervals of time after preparation, it is suggested that a molecular change may be produced by light. (auth)

Safety Procedures

Refer also to abstract 35730.

35760 (ORNL-tr-2151) OCCUPATIONAL RADIATION EXPOSURE IN THE GERMAN DEMOCRATIC REPUBLIC IN 1966. Brasack, G. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Translated for Oak Ridge National Lab., Tenn., from report SZS-20/68. 15p. Dep. CFSTI.

Data of the central personnel dosimetry in the G.D.R. are presented for 1966. Twenty-five thousand persons were controlled by the Radiation Protection Centre with film badges. Altogether, 985 monthly over-exposures (more than 0.4 Rad) were recorded. In 37 cases the quarterly dose (3 Rad) was exceeded during one month, but only 21 of those were true over-exposures. The greater part of over-exposures is attributable to insufficient attention to safety regulations. Furthermore, the results were analyzed according to type of institution, type of employment, as well as to the age of employees. (auth)

35761 SAFETY MEASURES FOR PROCESSING SUBSTANCES CONTAINING BERYLLIUM. Moench, S. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Metall, 23: 238-42(Mar. 1969). (In German).

Various methods for air monitoring and the possibilities for determination of small amounts of beryllium as safety measures in the processing of beryllium are discussed. Allowable concentrations, control methods, and protective arrangements are considered. (M.C.G.)

35762 JOACHIMSTAL LUNG CANCER AFTER THE SECOND WORLD WAR: REPORT OF 55 CASES. Horacek, Jiri (District Hospital, Karlovy Vary, Czech.). Z. Krebsforsch., 72: 52-6(1969). (In German).

The autopsy records of the hospital in Karlsbad (Karlovy Vary) revealed 16 cases of lung cancer of workers in the uranium mines of Joachimstal who died during the Second World War, and 18 cases from the post-war period up to 1961. Between 1962 and 1966, 55 cases of lung cancer from Joachimstal U miners were autopsied. Compared with the previous cases reported by Sikl, the shorter time of exposure (50% under 11 yr vs a single case) and a higher percentage of small-cell carcinomas (70% vs 57%) are noteworthy. The occurrence of lung cancer in uranium miners as shown by recent records was studied. This report is considered supplementary to the review of earlier cases by Sikl in 1938. Carcinoma cell type, lobe(s) of localization, site of metastases, cause of death, consumption of cigarettes, and yearly incidence of cases are tabulated. Duration of exposure to ionizing radiation from radionuclides in the causation of lung cancer is considered. The shortest exposure time in this series was 4 yr and the longest 25 yr. In more than half of the cases, occupational exposure was less than 11 yr. For the shortest exposures the total of exposure time plus latent period was 8 to 9 yr as a minimum. (BBB)

Legal Aspects

35763 (CEA-CONF-1281) RADIOACTIVE WASTE REGULATORY AND SOCIAL ASPECTS. Bresson, G.; Lacourly, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1969]. 15p. (In French). (SM-117/11; CONF-690317-2). Dep.

From Seminar on Agricultural and Public Health Aspects of Environmental Contamination by Radioactive Materials, Vienna, Austria.

The importance of establishing national as well as international standards in accordance with the recommendations of the ICRP is emphasized. The national French legislation considers protection against radioactive pollution in the broader framework of sanitary protection against nuisances of all kinds. On the other hand, recommendations or directives arising from specific international instances are much more specific for radioactivity. National aspects of the problem of radioactive pollution are considered from the standpoints of the nature of the installation and the nature of the waste material. The roles of the atomic energy minister and the minister of public health and population in authorizing the building of nuclear installations are discussed. Opinions on particular regulations applicable to each installation are given by an interministerial commission of nuclear installations following an inquiry into the requests for authorization. Regulations concerning emission into the atmosphere of fumes, soot, radioactive dust, toxic, corrosive, odorant, or radioactive gas are discussed. Legal aspects of water pollution are discussed, and three perimeters of protection are described. International aspects of radioactive contamination in the environment of nuclear installations are considered. Pollution of the atmosphere and surface waters of international zones by installations near the frontier creates particular problems. A survey of the effects of radioactive pollution on various population groups is recommended as a measure of protection to be considered among socioeconomic aspects. (H.L.W.)

35764 SURVEY OF VETERINARY X-RAY UNITS IN ALABAMA. Willis, William T.; Cowan, J. Edward (Dept. of Public Health, Montgomery, Ala.). Radiol. Health Data Rep., 10: 191-5(May 1969).

The Alabama State Department of Public Health conducted a radiological health survey of 65 x-ray units and fluoroscopes used in veterinary medicine to determine the nature and extent of radiological health hazards occurring during the operation of these units and to reduce the hazards to the lowest possible level. As a result of the survey, 64 of the 65 units complied with the state regulations for controling exposure as opposed to only 26 units that were in compliance at the time of the initial survey. The extent of compliance to state regulations regarding filtration, shielding, and personnel monitoring led to the conclusion that veterinary x-ray units were not a significant factor in regards to public safety. (E.R.B.)

Medicine

Refer also to abstracts 35047, 35432, 35544, 35701, and 36817.

35765 (ORAU-107) 1968 RESEARCH REPORT. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.). 327p. Dep. CFSTI.

Research in cytogenetics, experimental radiotherapy, hematology, immunology, pathology, and ultrastructural anatomy during 1968 concerning the elucidation of mechanisms of radiation injury and its treatment is described. A total of 93 papers is included in the report; 41 of these were abstracted for inclusion in NSA. Others outside the scope of NSA included the 21 papers in the section on lipid metabolism, nine papers on immunologic studies and the development of the marmoset as a laboratory primate, three papers on computer technology. (C.O.)

For abstracts of individual papers see: 35462-35464, 35519, 35582, 35583, 35594-35602, 35663-35665, 35684, 35685, 35727-35729, 35765, 35787-35792, 35816-35818, 35841, 35912-35914, and 35943-35947.

Protective Substances

Refer also to abstracts 35633, 35634, 35780, 35877, and 35938.

35766 (AD-682568) PROPHYLACTIC AND THERAPEUTIC ACTION OF SOMATOTROPIC HORMONE IN RADIATION AFFECTION. Grodzenskii, D. E.; Rabkina, A. E.; Bagramyan, E. R. Translated from Probl. Endokrinol. Gormonoter., 4: 31-7(1958). 12p. CFSTI.

STH facilitates the maintenance of weight in animals irradiated with sublethal and minimum lethal doses of x rays, but does not increase their survival times. Joint administration of STH, DOCA, and salt solution exerts a significant influence on the weight of the animals and hastens their death. The administration of STH prior to irradiation with sublethal doses of x rays exhibits a definite protective effect. In irradiated animals, STH increases the weight of the adrenals and normalizes the absolute weight of the endocrine glands and internal organs. In control rats, the weight of the adrenals, thyroid and testes is increased in comparison with that of the irradiated animals. (USGRDR)

35767 REACTIVITIES OF RADIATION-PROTECTIVE AMINOALKYLISOTHIURONIUM SALTS. 4. STABILITY OF N-ETHYL DERIVATIVES OF 2-AMINOETHYLISOTHIURONIUM SALT. Hanaki, Akira; Xumsaeng, Pranod (National Inst. of Radiological Sciences, Chiba, Japan). Chem. Pharm. Bull. (Tokyo), 17: 677-81(Apr. 1969).

The effect of N-substituent on the stability of an aqueous solution of AET was studied. By the substitution, both the transguanylation and the cyclization were hindered. The reactive species of N-Et-AET, and probably of N'-Et-AET, is the monoionic conjugate base for the transguanylation. N'-Et-AET, being relatively stable in the presence of less than one equivalent alkali, may be dissociated through the two-steps ionization to the neutral conjugate base, which would be considered as one of the reactive species. The degree of the transformation of N-ethylated AET derivatives was as follows; the transguanylation in the presence of 0.5 equivalent NaOH for 4 min at 15°: AET; 0.95, N-Et-AET; 0.84, N'-Et-AET; 0.27; the cyclization in 3 days at 30°: AET; 0.95, N-Et-AET; 0.36, N'-Et-AET; 0.29. The relationship between the transguanylation and the pH drop in the solution was discussed. (NSA of Japan)

35768 PHARMACOLOGICAL STUDIES ON CHEMICAL PROTECTORS AGAINST RADIATION. 5. ESTABLISHMENT OF BIOASSAY FOR RADIO-PROTECTOR. Shinoda, Masato; Shimizu, Setsuko (National Inst. of Radiological Sciences, Chiba, Japan). Yakugaku Zasshi, 88: 1031-8(Aug. 1968). (In Japanese).

Examinations were made on the potency test method for chemical radioprotectors using the life-prolongation effect on x irradiated mice as the indicator. Standards used for this test were AET and MEA. Male ddY mice were irradiated with 600 to 900 R of x rays and the animals were observed for the next 90 days to find optimal conditions for the potency tests. When the survival rate of irradiated mice is to be used as the indicator for potency tests of radioprotectors, the mice should be irradiated with a dose of x rays (700 to 900 R) by which all the control mice will be dead about 2 weeks after the irradiation and the survival rate of the mice in experimental group should be measured at the time when the survival rate of the control mice becomes 0%. When the survival time of irradiated mice is to be used as the indicator for potency tests of radioprotectors, the mice should be irradiated with a dose of x rays (700 to 800 R) by which the mean survival time of the control mice becomes about 10 days, mean survival time of the experimental group is measured 30 days after the irradiation, and protective potency is calculated by comparison of the mean survival time with that of the control group. Comparison of the minimum effective doses of AET and MEA indicated that there is a difference in the molar potency of the two compounds and AET was found to be 2 to 8 times stronger than MEA. (NSA of Japan)

35769 RELATIVE BIOLOGICAL EFFECTIVENESS OF ^{60}Co γ-RAYS ON THE TESTES WEIGHT LOSS OF THE MOUSE, AND INFLUENCE OF S-2-AMINOETHYLISOTHIURONIUM Br–HBr. Okamura, Shigeaki; Umayahara, Akira (Kyushu Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1572-7(Mar. 1968). (In Japanese).

The relative biological effectiveness of ^{60}Co γ rays and the effects of AET were studied using the testes weight loss of CF # 1 male mouse. Testes weight of the mouse with or without AET pretreatment was measured 30 days after whole-body irradiation of 200 kVp x rays or ^{60}Co γ rays. From the present study, the following relationships of dose and testes weight were obtained for each following group respectively: x rays, $W = -99.008 \log D + 351.40$; x rays + AET treatment, $W = -106.529 \log D + 369.92$; γ rays, $W = -107.336 \log D + 379.43$; γ rays + AET treatment, $W = -100.812 \log D + 367.93$; where W is the testes weight (mg) and D is absorbed dose (rads). From these results, it was concluded that AET can not modify the testes weight loss, and AET can not influence the relative biological effectiveness of ^{60}Co γ rays. The equal effect ratio of γ rays was 0.8, and the equal dose ratio was 0.9. (NSA of Japan)

35770 INFLUENCE OF LOCAL APPLICATION OF VITAMIN A PREPARATION IN THE COURSE OF POST-IRRADIATION SKIN REACTIONS IN MAN. Szymczykowa, Bogumila. Pol. Przegl. Radiol. Med. Nukl., 32: 529-35(July-Aug. 1968). (In Polish).

Results are presented from assays of the radioprotective action of vitamin A on human skin after local application. Based on reference data, the characteristic properties of vitamin A are discussed. In the experiment, the vitamin A was applied on the skin surface as 1 and 0.5% ointments prior to x irradiation. The post-irradiation reaction was compared with control fields, where the skin was covered with ointment without vitamin A. The differences in reactions were documented through photograms. It was concluded that vitamin A gives a radioprotective action when used during radiotherapeutic procedures in cases of skin diseases. (auth)

35771 AN EXPERIMENTAL PATHOLOGICAL STUDY OF THE DAMAGES AND RECOVERY OF THE HEMATOPOIETIC TISSUES AFTER TOTAL-BODY IRRADIATION, WITH SPECIAL REFERENCE TO THE EFFECTS OF CORTICOSTEROIDS. Asano, Takeshi (Nihon Univ., Tokyo). Nichidai Igaku Zasshi, 27: 1095-1113(Oct. 1968). (In Japanese).

The protective effects of corticosteroids against damage induced by whole-body irradiation in the hematopoietic organs were studied in mice. The mice were divided into four groups as follows: irradiated group given whole-body radiation; a group given whole-body irradiation with hydrocortisone administered shortly after irradiation; a group with bilateral adrenalectomy followed by whole-body irradiation; and a group with adrenalectomy and whole-body irradiation followed by hydrocortisone administration. These groups were studied chronologically and examined for changes in the spleen, bone marrow, lymph nodes, and thymus. A remarkable reduction of the organ weight of spleen and retarded recovery of hematopoiesis were observed in the two groups given an excess of hydrocortisone. This indicated that the excessive presence of hydrocortisone increased the radiation tissue damage and slowed the rate of recovery. Histological studies showed severe damages of hematopoietic tissue and retardation of recovery of lymphopoiesis in particular. The group in which adrenalectomy was followed by irradiation showed a slight reduction of the weight of spleen in contrast to the other three groups which were characterized by the presence of corticosteroids. Histological examination revealed that there was rather slight damages of lymphoid tissue and fair recovery in lymphopoiesis, but poor recovery of myelopoiesis in contrast to the three remaining groups. Histological examination of bone marrow revealed almost similar findings in erythro- and myelopoiesis to those in the red pulp of the spleen and the changes of lymph nodes were also similar to those of the white pulp of spleen. In the thymus both irradiation and hydrocortisone effects were found to be most prominent, indicating severe damages and retarded recovery. It was concluded that the adrenal cortex, especially in the presence of glucocorticoids, exerts a protective effect against radiation damage and promotes recovery of hematopoiesis except for lymphopoiesis. (NSA of Japan)

35772 STUDIES ON A LEUKOCYTOSIS-INDUCING ANTIBIOTIC AGENT, MARIMYCIN. Soeda, Momoe. Nippon Igaku Hoshasen Gakkai Zasshi, 28: 377-91(May 1968).

The protecting activity of injected Marinamycin against ^{60}Co γ and x radiation was clinically tested in mice and rabbits. The anti-leukopenic effects of Marinamycin were studied on the peripheral WBC of normal rabbits, the WBC count of x- or ^{60}Co γ-irradiated rabbits exposed to doses of 300 to 400 R, and on leukopenia induced by anti-cancer drugs. Marinamycin had the specific activity of inducing a significant degree of leukocytosis, and was effective in recovery from leukopenia developed in animal before and after irradiation. This agent seems to be useful to suppress the occurrence of a significant degree of leukopenia caused by local irradiation with daily therapeutic dose of 200 to 300 R and to prevent the danger of complications caused by decrease of leukocytes in the blood. It was clinically demonstrated to be almost non-toxic and could be used in the daily dose of 20 to 40 mg consecutively for more than 50 days without any appreciable side effects necessitating immediate discontinuance of its administration. Chemical agents such as cysteamine, cystamine, cystein, and AET were tested and failed to modify post-irradiation leukopenia. (NSA of Japan)

35773 COMPARATIVE PROTECTION BY A COMBINATION TREATMENT IN MICE IRRADIATED WITH FISSION NEUTRONS OR X-RAYS. Vogel, Howard H. Jr.; Hasegawa, Andrew T.; Wang, Richard I. H. (Argonne National Lab., Ill. Wood Veterans Administration Center, Milwaukee). Radiat. Res., 39: 57-67 (July 1969).

A triple treatment, including preirradiation protection by a chemical mixture (7 μmoles of AET, 25 μmoles of MEA, and 2 μmoles of serotonin, injected intraperitoneally, 0.4 ml/mouse), postirradiation administration of 5×10^5 nucleated homologous bone marrow cells intravenously, and daily subcutaneous injections of the antibiotic streptomycin (5 mg in 0.5 ml of saline), for 10 days after irradiation, was used in CF No. 1/ANL mice exposed to single supralethal whole-body doses (400 to 600 RAD) of either fission neutrons (CP-5 Reactor) or 900 to 1700-R doses of 250-kVp x rays. Irradiations of each group of mice were completed in less than a hour. In the x-irradiated mice this multiple treatment elevated the $LD_{50(30)}$ from approximately 675 R to more than 1700 R, a dose-reduction factor (DRF) in excess of 2.5. In comparison, the $LD_{50(30)}$ for neutron-exposed animals was increased by a factor of less than 1.3. When the pre-x irradiation treatment with the chemical mixture was used alone, the $LD_{50(30)}$ of female CF No. 1/ANL mice was raised from 675 R to 1200 R or more (DRF = 1.8). With a similar chemical mixture, the $LD_{50(30)}$ of neutron-irradiated mice, was increased less than 10%. These results indicate the value of a multiple approach in protecting against the deleterious effects of either x irradiation or neutron irradiation. The data further imply that greater injury and/or less recovery occurred in the neutron-exposed mice. (auth)

35774 PROTECTION BY CYSTEAMINE AGAINST LETHAL X-RAY DAMAGE DURING THE CELL CYCLE OF CHINESE HAMSTER CELLS. Sinclair, Warren K. (Argonne National Lab., Ill.). Radiat. Res., 39: 135-54(July 1969).

Cysteamine has a differential protective effect on x-irradiated Chinese hamster cells at different stages of the cell cycle. The agent protects most effectively the most sensitive cells so that the effect is a partial leveling of the structure normally seen in the age response. In subline V79-S171, dose-modifying factors (DMF) of about 5.0 were observed for sensitive mitotic and G_2 cells, about 4.2 for G_1 and early S cells (of intermediate sensitivity), and about 3.3 for resistant late S cells. A similar variation in DMF was observed in a longer G_1 subline, V79-325. This differential response contrasts with the lack of variation found in the oxygen enhancement ratio during the cell cycle and rules out hypoxia as more than a partial explanation for protective action of sulfhydryl agents. The disulfide, cystamine, failed to protect Chinese hamster cells at any phase of the cell cycle. Cysteamine also protected against the sensitization to x rays induced by prevention of

DNA synthesis when hydroxyurea was added to G_1 cells. Again, the effect was toward a leveling of the age response. Cysteamine also had some additional effects, smaller in magnitude, that may be indicative of its action. First, there was a level (about 1 mM) at which cells in G_1 were protected and cells in early S were slightly sensitized. Second, there was a small post-irradiation protection effect in G_1 cells but not in S cells. Third, G_1 or S cells to which cysteamine had been added and then removed were slightly more sensitive to subsequent x irradiation. Cysteamine treatment at room temperature reduced the rate of DNA synthesis when cells were restored to 37°C and also reduced the rate of DNA synthesis when added at 37°C. (auth)

35775 EFFECTS OF IONIZING RAYS ON PLANT CELLS. Biebl, R. (Inst. of Plant Physiology, Vienna). Tsitologiya, 11: 605-15(May 1969). (In Russian).

Tissue cells of higher plants are an excellent biological object to study effects of ionizing rays. Exceptionally suitable are plant cells, that can be observed without or only with little preparation (leaflets of bryophytes, epidermis of onion scales of Allium cepa). For a given species the lethal dose of α irradiation, expressed as the product of irradiation intensity × exposure time, is very constant under the same conditions. First effects in α-irradiated cells of moss leaflets are a rounding and displacement of chloroplasts, an increase of the protoplasmic viscosity, and an increase of the permeability for water or electrolytes. The survival curves of α-irradiated epidermises of onion scales show a rapid drop within 24 hr after intensive irradiation, while in epidermises exposed to lower doses of radiation death occurs only after some days. Cell death within 24 hr is believed to be caused by direct damages of the cytoplasm, the slow death after some days, on the other hand, by injuries of the nuclei, that are caused by much lower doses and that have a gradually increasing harmful effect upon the metabolism of the cell. Our observations refer, unless stated otherwise, to the radiation resistance of cytoplasm within 24 hr. The resistance to α- and uv irradiation exhibits remarkable seasonal and diurnal changes. Allium cepa and leaflets of Bryophytes show an opposite reaction. Outer and inner epidermises of onion scales of Allium cepa are most sensitive to irradiation (α, uv) in June and most resistant in December. Moss leaflets on the other hand have the highest resistance in summer and the lowest in winter. The size of the nuclei shows also seasonal changes and in both cases the smallest nuclear size corresponds to highest radioresistance and the biggest nuclei correspond to the minimum of radioresistance. This is in agreement with the results of Sparrow and coworkers. The diurnal changes in radiosensitivity of Allium cepa and moss leaflets are also opposite. Whereas epidermises of Allium cepa show their highest resistance at noon, Mnium rostratum is more resistant at midnight. Also these changes are accompanied by variations in the volumes of nuclei, but here we find the biggest nuclei linked with highest radioresistance and at the time of highest radiosensitivity the nuclear size is smallest. The larger nucleus in the diurnal rhythm, which is probably more active, seems to have supplied the cytoplasm with substances (enzymes?) that in spite of heavy damage to the nucleus itself, make it possible for the cytoplasm to survive higher doses within 24 hr. Lower doses, however, that no longer affect the less radiosensitive cytoplasm, damage larger nuclei, in accordance with Sparrow's findings, more than the smaller ones. A noticeable chemical protection against the harmful effects of α- and γ irradiation resulted from pretreatment with 0.25 mol thioacetamide, thiourea, methylthiourea, and other substances. Quite another mechanism may be assumed for the therapeutic effect of glucose, fructose, saccharose, or glycerine by posttreatment. The protective effect of thiourea, thioacetamide, and other uv-absorbing substances, against uv irradiation is not chemical but physical in nature. (auth)

35776 EXPERIMENTAL CARCINOGENESIS, BRONCHIAL INTRAMURAL ADENOCARCINOMAS IN RATS FROM X-RAY IRRADIATION OF THE CHEST. Gross, Paul (Industrial Hygiene Foundation, Pittsburgh, Univ. of Pittsburgh); Pfitzer, Emil A.; Watson, Joseph; deTreville, Robert T. P.; Kaschak, Marianne; Tolker, Ethel B.; Babyak, Mary Ann. Cancer, 23: 1046-60(May 1969).

One hundred eighty-six rats and 202 hamsters, that survived the respective time periods when the first lung cancer was diagnosed in each species, had been given an exposure of 3000 R or 4000 R of x irradiation applied externally to the chest. About 43% of the rats, but only 2% of the hamsters, developed lung cancer. To enhance the prevalence of lung cancer, some of the irradiated animals were injected intratracheally with 9, 10-dimethyl-1, 2-benzanthracene (DMBA). Lung cancer prevalence in irradiated animals injected with DMBA was no higher than that in irradiated animals not so injected. Intratracheal injections of DMBA in non-irradiated rats did not result in tumor production but, in non-irradiated hamsters, DMBA caused a 6% prevalence of lung cancer. The mortality rate of both animal species showed a more than additive effect in animals given the higher x ray dosage plus intratracheal injections of either DMBA or iron oxide alone. The lung cancers in the irradiated rats predominantly affected bronchi (86%) and were mostly adenocarcinomas (88%). The cancers were generally intramural and were covered by an intact and normal surface epithelium. Their origin appeared to be from aberrant intramural glands. These glands are not found in the bronchi of germ-free rats but do occur in bronchi thickened by severe endemic chronic bronchitis. (auth)

35777 MECHANISM OF THE PROTECTION OF MICE BY ENVIRONMENTAL HYPOXIA. Vacek, Antonin (Kyoto Univ.); Minagawa, Yoji. Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1463-74(Feb. 1968).

The protective effect of environmental hypoxia against lethal effect of x-ray exposure was compared in mice of different strains and radiosensitivity (RF, CF#1 LD50/30 450 to 500 R; dd/YF, DBA/2, and C57B1/6 LD50/30 600 to 700 R). Mice of strain dd/YF, DBA/2 and C57B1/6 were well protected by hypoxia as compared with those in strains RF and CF#1. Hypoxia protected decrease of the weight of intestine on the 3rd day after irradiation in a comparable level as in RF and dd/YF strain. Reduction of oxygen content in environment during irradiation correlates with mean endogenous spleen colony (ESC) counts in each strain of mice used. The mean ESC count is in good agreement with the intensity of protection of mice by environmental hypoxia. In RF and CF#1 mice a higher tolerance to hypoxia was observed than in other strains. Tolerance of mice to hypoxia correlates with protection by 10% oxygen and mean ESC count. The course of ^{59}Fe uptake in spleen and femur after irradiation at 700 R in air or hypoxia suggests that hypoxia protected bone marrow cells while no protection of hematopoietic tissue of spleen was observed. (NSA of Japan)

35778 TOXICITY OF RADIOPROTECTIVE AGENTS TO YEAST. Markoe, A. M.; Stannard, J. N. (Univ. of Rochester, N. Y.). Radiat. Res., 39: 90-100(July 1969). (UR-49-994).

The toxic effects to baker's yeast of four sulfhydryl compounds frequently used as radioprotectants: cystamine, cysteamine, cysteine, and dithioerythritol (DTE) are considered. All but cysteine markedly reduced colony formation at concentrations above 10^{-4} M. The rate of action on colony formation varied. Cystamine required at least 1 hr of exposure to produce an effect, and then it developed slowly, while the others manifested their action rapidly. All the agents inhibited exogenous respiration with dextrose to some degree, while their action on endogenous respiration was either small and variable or a stimulation. All caused a small but significant increase in the number of cells staining with methylene blue dye, but this was insufficient to account for the inhibition of colony formation by death of the cells. None of the effects measured bear a consistent relation to the radioprotective ability of these compounds in single cells or in higher organisms. Therefore, it is unlikely that identical or closely correlated mechanisms underlie the toxic effects and the ability to protect against x-ray damage. Nevertheless, the toxic concentrations in the case of all but cysteine lie close to or are lower than those needed for radioprotection. This raises questions as to the extent to which the protected cell population resembles the unprotected cells in expression of radiation effects. (auth)

35779 EFFECT OF SEROTONIN ON ^{32}P AND GLYCINE-1-^{14}C INCORPORATION IN ACID SOLUBLE NUCLEOTIDES OF MITOCHONDRIA IN RABBIT BRAIN. Zryakov, O. M.; Kurskii, M. D. (Inst. of Biochemistry, Kiev). Ukr. Biokhim. Zh., 40: 549-52(1968). (In Ukrainian).

The dynamics of ^{32}P incorporation injected intravenously in acid soluble purine nucleotides was studied in homogenates and mitochondrion fractions of rabbit brain. Serotonin injected into the large cistern of the brain 23 hr after intravenous injection of ^{32}P increased the specific radioactivity of AMP, ADP, and ATP. Serotonin and ^{32}P simultaneously injected intracisternally caused an increase of specific radioactivity of ATP, ADP, AMP, GTP, and GMF. Serotonin also increased the intensity of glycine-1-^{14}C incorporation in adenyl nucleotides of the mitochondrion fraction of rabbit brain.

Radiation Sickness and Injuries

Refer also to abstract 35766.

35780 ON THE PROTECTIVE EFFECT OF THE MICELLE OF HIGH FUNGI UPON ACUTE RADIATION SICKNESS. Toreva,

D.; Slavcev, G.; Marovski, T. (V. Kolarov Higher Agricultural Inst., Plovdiv, Bulgaria). Folia Med. (Plovdiv), 10: 110-14(1968).

The effect of the micelle of high fungi upon acute radiation sickness has been studied by adding it to the diet of test animals (albino rats.) As a rich protein and vitamin biological product, the micelle of high fungi, in particular the one of Cantharellus cibarius, contributes to strengthening the protective power of animals and to restoring their normal blood picture and weight. Animals on a diet containing prophylactic supplement of micelle, preserve their fertility to a greater extent after irradiation. (C.O.)

35781 HEMATOLOGICAL CHANGES DURING THE REPAIR OF SKIN DAMAGE IN IRRADIATED RATS. Stojanovic, Dragoslav; Milovanovic, Aleksandar; Stajic, Jovan. Bull. Boris Kidric Inst. Nucl. Sci., 19: Biol., No. 5, 31-42(Dec. 1968).

The dynamics of changes in the numerical values of leukocytes in peripheral blood in rats with a combined ^{60}Co γ radiation and mechanical damage has been investigated. The quantitative changes of the total leukocyte counts, the differential blood picture and changes in the quantitative relation between small and large lymphocytes in peripheral blood in conditions when the trauma appeared in the postacute period of the radiation sickness (between the 15th and 90th day after exposure) were observed. These changes were also simultaneously investigated in animals injected with a mixture of methionine and cysteine for the purpose of stimulating the healing process. Certain dependence of the leukocyte reaction on the interval between radiation and wounding which is conditioned by the dominating radiogenetic or mechanical components of the combined injury has been observed. Treatment with thioaminoacids results in the faster restoration of leukocytes and a favorable effect both on the radiogenetic lesion and the reparatory processes in the wound. This effect is more pronounced if the trauma appears in the early phases of recovery from radiation lesion. (auth)

35782 EFFECT OF PARENTHERAL APPLICATION OF METHIONINE AND CYSTEINE ON THE REPAIR OF MECHANICALLY DAMAGED SKIN IN IRRADIATED RATS. Stajic, Jovan; Stojanovic, Dragoslav; Milovanovic, Aleksandar Bull. Boris Kidric Inst. Nucl. Sci., 19: Biol., No. 2, 9-14(Oct. 1968).

Repair processes in the skin wound of rats, inflicted in different periods between the 15th and 90th days after whole-body gamma irradiation with a dose of 900 rads, have been studied. The therapeutic healing effect of postoperative application of a mixture of methionine and cysteine on the wound inflicted in the above described conditions has been investigated. Results have shown that repair processes in the wounds of surviving irradiated animals are upset irrespective of the time interval between irradiation and infliction of the wound. The postoperative treatment with thioaminoacids had a favorable effect on wound healing in most of the experimental groups. (auth)

35783 RADIOPROTECTIVE EFFECT OF RAT KANGAROO HAEMATOPOIETIC CELLS ON X-IRRADIATED MICE AND CHINESE HAMSTERS. Yao, Kenneth T. S. (National Center for Radiological Health, Rockville, Md.). Int. J. Radiat. Biol., 15: 191-4(1969).

Serially cultured cells derived from rat kangaroo (Potorous tridactylus) bone marrow and spleen tissues were inoculated into lethally x-irradiated mice and Chinese hamsters to test the radioprotective effect of the long-term cultured cells. Mice were 9 weeks old and hamsters were 7 weeks old when they were irradiated at the rate of 52 rads/min at single exposures of 800, 1200, or 1600 rads. Mice were injected (intravenously) with 2.5×10^6 cells and hamsters were injected (intraperitoneally) with 10×10^6 cells. Results are presented in tabular form and briefly discussed. In general, mice were protected from x radiation by injection of cells but the Chinese hamsters were not; cells injected intravenously were thought to be more radioprotective. (C.O.)

Radiodiagnosis

Refer also to abstracts 35462, 35479, 35500, 35597, 35598, 35658, 35725, 35741, 35754, 35813, and 35820.

35784 (ACRH-31, pp 1-11) COMPARISON BETWEEN SENSITIVITY AND RESOLUTION BASED ON A CLINICAL EVALUATION WITH THE ACRH BRAIN SCANNER. Gottschalk, A.; Abatie, J. D.; Petasnick, J. P.; Polcyn, R. E.; Beck, R. N.; Charleston, D. B. (Argonne Cancer Research Hospital, Chicago, Ill.).

The Argonne Cancer Research Hospital (ACRH) brain scanner is intermediate in sensitivity between most conventional scanners and stationary detector systems and the Anger camera. It uses four collimated detectors arranged in opposing pairs that scan the head concurrently, and yield simultaneous lateral or anterior and posterior photoscans recorded with a data blending system. High resolution collimators are utilized and the resultant loss in sensitivity is offset by the multiple detectors. Consequently, it is possible to obtain high quality brain scans in both laterals and anterior and posterior projections with as little as 20 min of total scanning time per patient for all four views. An adult dose of 10 mCi of ^{99m}Tc-pertechnetate is used and scanning begun 10 min after intravenous injection. A clinical evaluation of the ACRH brain scanner to determine whether the detection of focal intracranial disease can be improved with better resolution as compared with conventional scanning systems is presented, and the effect and clinical significance of improved resolution on the characterization of lesions are discussed. (E.R.B.)

35785 (ACRH-31, pp 12-24) EVALUATION OF SCANNING PROCEDURES IN TERMS OF INFORMATION THEORY. Harper, P. V.; Beck, R. N.; Cohen, T. D. (Argonne Cancer Research Hospital, Chicago, Ill.).

The basic purpose of a mathematical description of a practical engineering process is to weave together the associated common sense and intuitive notions into a quantifiable pattern that hopefully will generate further insight into the problem and permit further refinement of the process. Some basic notions in connection with scanning are: A coarse focus detector that will depict a large organ such as the liver fairly well is not of much use for scanning a small organ such as the thyroid. In a low count, low contrast situation such as parathyroid scanning, even though the object being scanned is very small, it is hopeless to use anything but a high sensitivity, coarse focus collimator. An attempt is made to incorporate such widely diverse requirements into a consistent mathematical theory using the methods of the information theory as developed by Shannon. While a number of efforts in this direction have been reported, the formulation of scanning resolution in terms of modulation transfer by Beck has enlarged the scope and flexibility of the subject considerably and provided additional avenues of approach. (auth)

35786 (ACRH-31, pp 25-44) EFFECTS OF SCATTERED RADIATION ON SCINTILLATION DETECTOR RESPONSE. Beck, R. N.; Schuh, M. W.; Cohen, T. D.; Lembares, N. (Argonne Cancer Research Hospital, Chicago, Ill.).

In every medical radioisotope imaging procedure the object to be imaged is a three-dimensional distribution of radioactive material, that can be thought of as a low-intensity, self-luminous object embedded in a turbid medium that scatters and absorbs the primary radiation emitted by the object. An adequate theory of radioisotope imaging systems must enable us to predict the images of such objects, including the effects of scattered radiation. Concepts and procedures for quantifying the effects of scatter on the sensitivity and spatial resolution, and a criterion for obtaining an optimum compromise between these effects are described. The example of brain scanning with systems employing collimated scintillation detectors is used to illustrate the theory that can be applied to other radioisotope imaging procedures. (E.R.B.)

35787 (ORAU-107, pp 21-3) LEUKOKINETIC STUDIES USING ^{32}P-DFP IN CHRONIC GRANULOCYTIC LEUKEMIA. Vodopick, Helen; Rupp, Elizabeth M.; Goswitz, Francis A.; Edwards, C. L. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Granulocyte disappearance rates were determined in patients with chronic granulocytic leukemia (CGL) using the ^{32}P-labeled diisopropyl fluorophosphate cell labeling technique. Six patients with CGL in relapse were studied; all except one of these patients had biphasic or triphasic disappearance curves. Data are presented in graphic and tabular form and will serve as a base line for comparison with other studies in these patients under different clinical and therapeutic conditions. (C.O.)

35788 (ORAU-107, pp 119-25) TUMOR SCANNING WITH ^{67}Ga. Edwards, C. L.; Hayes, R. L. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Clinical studies using gallium-67 citrate (carrier-free) as a specific scanning agent for extracranial soft-tissue tumors are reported. Several types of neoplasms were visualized on scans with unusual contrast. Twenty-six patients were studied and results are presented in tabular form. A mechanism responsible for localization of this radionuclide was suggested and briefly discussed. (C.O.)

35789 (ORAU-107, pp 136-7) ASSESSMENT OF ERYTHROPOIESIS BY FERROKINETICS AND RADIOCOLLOID BONE-MARROW SCANNING. Goswitz, Francis A.; Edwards, C. L.; Vodopick, Helen (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Seventeen patients with various erythropoietic disorders were studied to compare ferrokinetic data and bone marrow patterns

shown on scans to determine if the ^{198}Au scan could be used to assess erythropoiesis or supplement ^{59}Fe data. Results are illustrated and briefly discussed. It was concluded that although the ^{198}Au bone-marrow scan cannot yield quantitative data on erythropoiesis, it adds information about disorders of red-cell production when correlated with ^{59}Fe and other hematologic studies. (C.O.)

35790 (ORAU-107, pp 140-2) VALUE OF PLASMA ^{59}Fe DISAPPEARANCE IN DETERMINING IRON-DEFICIENT ERYTHROPOIESIS. Goswitz, Francis A. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The plasma ^{59}Fe clearance proved to be useful in the detection of iron-deficient erythropoiesis that is manifested by absence of iron in the bone marrow. Eleven patients with no stainable marrow iron, including three with myofibrils, received an intravenous injection of ~0.1 μCi of ^{59}Fe/kg body weight. Ten had plasma disappearance curves for ^{59}Fe with half-times of less than 1 hr. Normal persons cleared ^{59}Fe (50%) from their plasma in 1 to 2 hr. The relation of saturated transferrin to the absence of bone-marrow hemosiderin was also determined; 9 of 11 patients had below normal values for percentage of saturated transferrin but only 7 of the 11 had a transferrin saturation of less than 16%. It was concluded that a rapid plasma clearance was useful in confirming the presence of an iron-deficient state in a patient with absence of stored marrow iron. (C.O.)

35791 (ORAU-107, pp 144-6) ADVANTAGE OF MEASURING BLOOD VOLUME WITH THREE RADIOISOTOPES. Goswitz, Francis A. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Nine patients with various hematologic disorders received intravenous injection of three radioisotopes, one after each 15-min period in the following doses: $R^{125}ISA$ (radioiodinated human serum albumin) 0.1 μCi/kg, ^{51}Cr-labeled RBC 2.0 μCi/kg, and then ^{59}Fe-labeled plasma 0.1 μCi/kg. Blood samples were collected at 15, 30, and 45 min intervals and then assayed for radioisotope content. The indirect measure obtained by the $R^{125}ISA$ and the ^{59}Fe studies overestimated the RBC mass in 7 of 9 patients. The study showed the value of measuring the RBC mass and the plasma volume independently since the indirect determinations of either the RBC mass from a measure of the plasma volume and venous hematocrit (HCT_v) or of the plasma volume from a measure of the RBC mass and HCT_v were frequently inaccurate. (C.O.)

35792 (ORAU-107, pp 221-3) PRINCIPAL PROBLEMS IN THE CLINICAL USE OF WHOLE-BODY COUNTING. Bergner, Per-Erik E. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Why so little clinical use is made of low-level whole-body counters is discussed. The main advantage of these counters was stated to be that the collection of urine and stools is eliminated. Since the physiology of the total metabolic system is so extremely complex, it is difficult to relate a set of data to a specific disorder in a specific patient. One approach involves statistical analysis or a phenomenologic approach; another approach attempts to deduce parameters from the analysis of retention data on a molecular basis (a physical approach). The value of animal research and the importance of diet are also discussed. (C.O.)

35793 AN IMPROVED ^{137m}Ba GENERATOR. Nagai, Teruo; Watari, Kazuo (National Inst. of Radiological Sciences, Chiba, Japan). J. Nucl. Med., 9: 608-9(Dec. 1968).

The fabrication of a ^{137m}Ba generator that ensures minimum contamination from the ^{137}Cs parent is described. Double layers of metal ferrocyanide anion exchange resin were used to separate ^{137}Ba and prepare solutions in sterile distilled water or physiological saline suitable for intravenous injection for clinical studies. (C.H.)

35794 DETECTION OF NEOPLASTIC BONE LESIONS BY QUANTITATIVE SCANNING AND RADIOGRAPHY. Greenberg, E. J.; Weber, D. A.; Pochaczevsky, R.; Kenny, P. J.; Meyers, W. P. L.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research and Memorial, New York. James Ewing Hospital, New York). J. Nucl. Med., 9: 613-20(Dec. 1968).

Bone scanning after the administration of ^{47}Ca or ^{85}Sr is a definite complement to radiological techniques for the diagnosis of bone lesions. Changes incident to early malignant bone lesions can be demonstrated before their detection by standard and special radiographic techniques. Bone lesions were detected by scanning 34 to 46 days before their appearance on radiographs. Further investigation of the local uptake patterns of normal and abnormal bone as a function of time may lead to the development of scan procedures that might possibly differentiate between malignant and certain non-malignant lesions in bone, something that is currently not possible. The fact that two out of 11 confirmed malignant bone lesions detected by scanning showed abnormal uptake only at times greater than 5 hr after injection of the nuclide stresses the importance of sequential scans up to 5 days. The additional observation of an increasing lesion-to-normal bone ratio in 10 of 11 patients for the serial readings over 5 days emphasizes that the time factor plays an important role in nuclide scanning for bone-lesion detection. (auth)

35795 RECTAL ADMINISTRATION OF Na ^{131}I AS A SCREENING TEST FOR LIVER METASTASES. Sannazzari, G. L.; Agati, G.; Bottero, G. (Univ., Turin). Minerva Radiol., 14: 35-40 (Jan.-Feb. 1969). (In Italian).

The value of the rectal administration of Na ^{131}I as a screening test for liver metastases was investigated. The test proved harmless, easy, and trustworthy in the presence of inequivocal hepatic localizations. The limitations of this method consist in its lack of specificity (it is positive in any condition associated with severe changes of the portal blood flow, whatever its nature) and in its low sensitivity in cases of mild hepatic lesions. This diminishes its value as regards an early recognition of liver metastases. (auth)

35796 PRELIMINARY RESULTS OF SURVEYS OF 5,263 MEDICAL X-RAY FACILITIES, 1962-1967. Radiol. Health Data Rep., 10: 235-46(June 1969).

Preliminary results of State surveys of 5,263 facilities with medical x-ray equipment are presented. Parameters such as equipment type and operating characteristics, personnel protection, workload, and certain aspects of operating technique were studied over a period from 1962 to 1967. The results of these studies will be considered together with other studies now in preparation and it is possible that some of the findings will be changed when the data are further evaluated for reporting to Congress under Public Law 90-602. (auth)

35797 PRACTICAL EVALUATION OF EXPOSURE DOSE TO PATIENTS AND PERSONNEL DURING RADIODIAGNOSTIC TESTS WITH THERMOLUMINESCENT DOSIMETRY. Busuoli, G. (CNEN, Bologna); Cavallini, A.; Pastremoli, A. Radiobiol. Radioter. Fis. Med., 23: 427-40(Nov.-Dec. 1968). (In Italian).

The results of research carried out by means of a type of thermoluminescent dosimeter (powder of LiF incorporated in a matrix of silicone rubber) for the evaluation of the dose to be given to patients and to the staff during radiodiagnostic tests are reported. Among the various precautions for the reduction of the exposure, the AA. insist on the advantages of the additional filtration of the beam. (auth)

35798 MEASURING DEVICE FOR THE INTERPRETATION OF RADIOGRAMS. Zamojda, Bazyli. Pol. Przegl. Radiol. Med. Nukl., 33: 215-20(Mar.-Apr. 1969). (In Polish).

A measuring device is presented for interpreting radiograms. This equipment supports the radiological diagnosis with numerical data; some findings are presented in degrees and centimeters. (auth)

35799 SPLENOPORTOSCINTIGRAPHY TO DEMONSTRATE PORTOSYSTEMIC SHUNTS. Hoefer, R.; Ogris, E.; Pfeiffer, G. (Second Medical Univ. Clinic, Vienna). J. Nucl. Med., 9: 624-9(Dec. 1968).

After intrasplenic injection of ^{131}I-labeled human serum albumin (MAA) in a patient with normal portal circulation, the liver and parts of the spleen could be visualized by scintiscanning. Accumulation of the tracer in the lung indicates the presence of portosystemic shunts. The degree of accumulation of MAA in the lungs depends on the volume shunted. The result may therefore be quantitated to some extent. Splenoportoscintigraphy is more sensitive for detecting portosystemic shunts than x-ray examination of the esophagus. (TSS) (auth)

35800 INFORMATION-SEARCH SYSTEM FOR X-RAY ARCHIVES. Zedgenidze, G. A.; Vlasov, P. V. (Inst. of Medical Radiology, Obninsk, USSR). Vestn. Rentgenol. Radiol., No. 2, 88-95(Mar.-Apr. 1969). (In Russian).

An information-search system and classification of diseases for systematization of x-ray material in roentgenological archives are described. It is pointed out that the form of recording the roentgenological data accepted at present in x-ray diagnostic departments fails to conform to the current scientific and practical requirements. This is mainly caused by the absence of proper classification. A classification that considerably widened the possibilities of roentgenological archives is elaborated. All x-ray data are ciphered and recorded on punchcards in accordance with the present classification. This information-search system permits selection of the required information according to nosological groups and the most significant signs. (auth)

35801 POTENTIAL VALUE OF TOLUIDINE BLUE ANALOGS AS PARATHYROID SCANNING AGENTS. Kang, Guprem S.; DiGiulio, Walter (Veterans Administration Hospital, Ann Arbor,

Mich. Univ. of Michigan, Ann Arbor). J. Nucl. Med., 9: 643-4 (Dec. 1968).

The quantitative distribution of toluidine blue (T.B.) was investigated in dogs to evaluate the potential of γ-emitting analogs of this dye for parathyroid gland scanning. While the uptake of T.B. per gram of dog parathyroid tissue 2 hr after its intravenous infusion was similar to the percent uptake of ^{75}Se-selenomethionine in some humans, the ratios of parathyroid concentration to that in thyroid, muscle, and blood were greater than with ^{75}Se-selenomethionine. These data suggest that ^{125}I or ^{75}Se labeled analogs of this dye may be excellent scanning agents, particularly for parathyroid-gland photoscanning. (C.H.)

35802 ANTIBODIES TO ENCEPHALITOGENIC BASIC PROTEIN IN EXPERIMENTAL ALLERGIC ENCEPHALOMYELITIS. Lisak, Robert P.; Heinze, Robert G.; Kies, Marian W.; Alvord, Ellsworth C. Jr. (National Inst. of Mental Health, Bethesda, Md. Univ. of Washington, Seattle). Proc. Soc. Exp. Biol. Med., 130: 814-18(Mar. 1969).

Radioimmunoelectrophoresis was used to detect antibodies to myelin basic protein (BP) in sera from guinea pigs given a single encephalitogenic challenge containing homologous BP or central nervous system tissues. Antibodies which were found in only 13% of sensitized guinea pigs were detected late in the course of disease and were found only in the 7S-γ_2 class of immunoglobulins. With such a low incidence, it is unlikely that this antibody has any pathogenetic significance. Although the incidence of antibodies is higher in guinea pigs with mild clinical and histologic evidence of allergic encephalomyelitis (EAE) than in the entire group, the increased incidence is not sufficient to suggest a protective function for the antibody. (auth)

35803 QUANTITATIVE ESTIMATION OF EXPERIMENTAL HEPATOMAS BY ^{198}Au-COLLOID. Matthes, Th.; Altenbrunn, H.-J.; Kuehn, B. (Institut fuer Krebsforschung, Berlin). Arch. Geschwulstforsch., 32: 353-7(1968). (In German).

A simple method to estimate the weight of hepatomas as well as that of intact liver in animals with hepatomas is described. Intravenously administered radioactive gold colloid is trapped in the RES of the liver. Hepatoma contains about one percent of radioactivity of the intact liver parenchyma. By estimation of whole liver activity and of activity of intact liver tissue, the amount of normally functioning liver tissue can be evaluated exactly. However, errors are possible in disseminated carcinomatosis when tumorous and nontumorous tissue can not be properly divided. (auth)

35804 REPORT OF SUBCOMMITTEE ON RADIATION PROTECTION IN DENTAL TEACHING AND PRACTICE. Schmidt, Arthur R.; McCollow, T. J.; Jordan, William A. North West Dent., 47: 278-80(Sept.-Oct. 1968).

The subcommittee on radiation protection was charged by a resolution of the House of Delegates in 1965 to investigate radiation protection procedures in the teaching and practice of dentistry and to present its findings and recommendations at the 1966 annual session of the Minnesota State Dental Association. The report of the subcommittee is given. (auth)

35805 STUDIES ON THE LUNG SCANNING WITH ^{131}I-MAA. Takanashi, Kenji (Chiba Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 579-89(Aug. 1967). (In Japanese).

The lung scanning is done 5 min after the intravenous administration of ^{131}I-MAA with the patient in supine position. The mean lung retention of ^{131}I-MAA 1 hr after administration, measured by the whole body counter, was 92.1%. The standard lung scan was obtained by scanning the lung phantom, containing 0.03 μCi ^{131}I-MAA/cc. By changing the ^{131}I-MAA density of each lobe of the lung phantom, various lung scans were obtained. According to these scans, lung scintigrams and chest films were compared and discussed. In case of lung hilus lesions, lung scans are considered better than chest films. (NSA of Japan)

35806 NUCLEAR INDICATORS OF SHORT PHYSICAL HALF LIFE IN CARDIAC HEMODYNAMICS. Kellershohn, C.; De Vernejoul, P.; Ivancevic, D. (Service Hospitalier Frederic-Joliot, Orsay, France). Arch. Mal. Coeur Vaisseaux, 60: 558-70(Apr. 1967). (In French).

The use of ^{137}Ba which has a half life of 2.5 min for the study of circulatory system and in radiocardiography is described and discussed. The high concentration of radioactivity that could be injected that delivered only small doses of irradiation had several advantages. The detector could be placed at a greater distance from the cardiac area, so that the difference of position of the various chambers in relation to the detector was negligible. The statistical accuracy of the counts was very high, which increased statistical reliability. Because the doses of radiation delivered were small, the examination could be repeated frequently. It was possible to study dilution of the indicator within a mass of blood smaller than the cardiac mass of blood, and to record dilution curves within a large vessel such as the abdominal aorta. The simultaneous dilution of ^{137}Ba at the level of the cardiac chambers and of the abdominal aorta was described. Comparison between the curves made it possible to detect, and to some extent to measure right-to-left shunts. Analysis of the aortic curve made it possible to show the existence of a counter-current due to an aortic valvular incompetence, and to measure it. The simplicity and the efficiency of the method were emphasized. (BBB)

35807 CHANGES OF THE DIPLOIC SPACE SECONDARY TO ANEMIAS MIMICKING INTRACRANIAL LESIONS ON TECHNETIUM SCINTISCANOGRAMS. Sewell, Patrick E.; Lang, Erich K. (Louisiana State Univ., Shreveport). J. Indiana State Med. Ass., 61: 1446-7(Oct. 1968).

The possibility of false diagnosis of brain lesions in scintiscanning with ^{99m}Tc is illustrated with reference to a patient with sickle cell anemia. After various symptoms in a 14-yr-old patient that suggested an intracranial lesion with vascular thrombosis, an anterior-posterior and lateral brain scintiscanogram was obtained, using ^{99m}Tc. Increased activity was demonstrated over a large area of the vertex. The diagnosis of a subdural hematoma was considered; however, correlation with the plain skull x-ray suggested the changes to be secondary to pooling of the radioisotope in a prominent diploic space occasioned by proliferation of the hematopoietic tissue. The plain skull roentgenogram demonstrated the typical hair-on-end appearance seen with hemolytic or chronic iron deficiency anemia, the osseous changes reflecting widening of the interdiploic trabeculae, secondary to proliferation of hematopoietic component. Scintiscanograms demonstrating areas of increased ^{99m}Tc uptake may often cause the erroneous interpretation of an intracranial lesion. The reported case is cited as an example of extracranial pathology occasioning this appearance. Lesions of the calvarium causing an increased vascular space and volume in the diploic space, such as Paget's disease, an arteriovenous fistula, hypervascular metastatic neoplasia and certain anemias, causing increased proliferation of the hematopoietic system and hence, the volumetric enlargement of the diploic space, classically caused this increased concentration of radioisotope. Certain soft tissue lesions and infection in the subgaleal space may likewise result in increased concentration of ^{99m}Tc and simulate an intracranial lesion. Use of ^{131}I-albumin and ^{87m}Sr to resolve this problem is suggested. (BBB)

35808 AN EFFECT OF GYNECOLOGIC CANCER ON PERIPHERAL BLOOD: ALTERED IN VITRO ERYTHROCYTE KINETICS OF ^{86}Rb. Overstreet, Edmund W.; Scott, Kenneth G. (Univ. of California, San Francisco). Amer. J. Obstet. Gynecol., 103: 801-9(Mar. 15, 1969).

A new radioisotope method was explored utilizing ^{86}Rb for the detection of gynecologic cancer. One of the authors showed earlier that when ^{86}Rb is added to peripheral blood in vitro, its transfer kinetics for erythrocytes appeared to be altered by the presence of a malignant tumor. High act. ^{86}Rb is added to heparinized peripheral venous whole blood. Absorption of ^{86}Rb by erythrocytes and subsequent equilibrium between them and the plasma are the result of 2 factors: the rate of active uptake of ^{86}Rb by erythrocytes (referred to as AU) and the rate of passive diffusion out of the cells (referred to as OD). By means of AU the cells maintain an osmotic gradient over plasma; OD depends upon the relative concentration of ^{86}Rb between cells and plasma. The rate of AU is measured at selected time periods after addition of ^{86}Rb and an uptake curve is constructed. From this specific rates for AU and for OD can be derived. In a preliminary study of 124 patients, of whom 55 served as controls, both the test index and the OD/AU balance ratio were significantly increased for the erythrocytes of patients harboring the principal types of gynecologic cancer, of patients with endometrial polyps or cystic hyperplasia, and of pregnant patients. There was no significant difference between the control patients and those with carcinoma in situ or patients whose prior treatment of gynecologic malignancy had presumably resulted in cure. (BBB)

35809 LUNG SCANNING AS A SCREENING METHOD FOR CANCER OF THE LUNG. Ernst, H.; Krueger, J.; Vessal, K. (Freie Univ., Berlin). Cancer, 23: 508-12(Feb. 1969).

After injection of ^{131}I-MAA (macro-aggregated human serum albumin), the authors obtained pulmonary scans from 500 patients with various pulmonary diseases. The results of scanning and of standard roentgenographic examination are compared on the basis of 138 cases with definitely diagnosed malignant pulmonary tumors In all cases with central tumors, i.e., tumors that were located near the hilus, the scan was abnormal and thus indicated a disorder of pulmonary perfusion. In contrast to this, radiologic examination (thoracic films in two planes and, if indicated, fluo-

roscope) only disclosed direct or indirect signs of cancer in 88% of these cases. Therefore, lung scanning as a screening method for central pulmonary tumors is a more sensitive diagnostic tool than standard roentgenographic examination. In cases of peripheral pulmonary tumors, a perfusion disorder which is larger than the radiologically recognizable lesion indicates central metastases. (auth)

35810 RELIABILITY OF BRAIN SCANS AND ELECTROENCEPHALOGRAMS IN COMBINATION. Spudis, Edward V.; Maynard, C. Douglas (Wake Forest Univ., Winston-Salem, N. C.). S. Med. J., 62: 529-31(May 1969).

Use of ^{99m}Tc-pertechnetate brain scanning along with electroencephalography (EEG) in 100 subjects with neurologic symptoms is reported. Brain scans were performed in four projections employing a 3-in. rectilinear scanner following the intravenous administration of 10 to 15 mCi of ^{99m}Tc. The brain scan complemented and corrected many deficits of the EEG. Abnormal ^{99m}Tc scans in known primary and metastatic lesions varied from 65 to 95%. The brain tumors missed were slow-growing lesions such as low-grade astrocytomas and pituitary tumors. Radioisotope scanning was also valuable in non-neoplastic lesions, such as arteriovenous malformations, chronic subdurals, abscesses, and cerebral infarctions. With cerebral infarction, the time at which the scanning is done in relation to the initial insult is extremely important since the highest percentage of positives occurs 2 to 3 weeks after the acute episode. This factor may account for the many negative scans obtained in patients with cerebral infarctions. The ^{99m}Tc brain scan is an excellent screening test because of its simplicity, accuracy, and safety. (BBB)

35811 COMPARATIVE SCINTIGRAPHIC AND MORBID ANATOMIC INVESTIGATIONS IN HEPATIC DISEASES. Zsubovski, G. A.; Savtshenko, E. D. Radiol. Diagn., 10: 15-24(1969). (In German).

In 30 cases with different diseases the results of hepatic scintigraphy and autopsy were compared and in 8 cases the causes of discrepancy of diagnosis analyzed. The radiologist who studies the hepatoscintigrams must know the fundamentals of scintigraphic semeiotics and simultaneously consider the clinical, laboratory, and biopsy findings. Often, insufficient consideration of physical and technical conditions (low resolving power of collimators etc.) are the cause of false diagnosis. (auth)

35812 ROENTGENOLOGIC AND SCINTIGRAPHIC DEMONSTRATION OF VENA PORTAE VIA VENA UMBILICALIS. Wirbatz, W.; Mateev, B.; Bauke, G.; Kiessling, J.; Georgi, P.; Altebrunn, H. J.; Richter, W. (Institut fuer Krebsforschung, Berlin. Pathologische Institut, Berlin). Arch. Geschwulstforsch., 32: 126-36(1968). (In German).

Casts of livers in situ made clear the anatomic conditions of the umbilical vein at its entrance into the portal system. This knowledge is an absolute condition for catheterizing the vena umbilicalis. The advantages and disadvantages of angiography and scanning of the liver via the umbilical vein (omphalo-portography, omphalo-portoscintigraphy) are discussed based on theoretical considerations and practical experiences. The omphal-portography is compared to arterial and venous angiography and to spleno-portography. Pictures more rich in contrast are received by injecting radio-opaque substances directly into the portal system; and even selective catheterization of the main portal vein or the rami principales is possible. But the omphalo-portography is not entirely harmless, because of possible injury at the entrance of the umbilical vein into the portal system. There are no essential improvements comparing omphalo-portoscintigraphy to conventional application of isotopes. The resolving power fixes the limits of liver scanning and cannot be improved by increasing the rate of incorporation. Direct injection of isotopes into the portal system allows registration of disturbances of liver circulation more accurately. (tr-auth)

Radiotherapy

Refer also to abstracts 35599, 35733, 35734, 35753, 35755, 35756, 35758, 35770, 35800, 35861, 35882, 35899, 35913, 35914, 35916, 35921, 35923–35930, 35945, 35947, and 37060.

35813 (ACRH-31) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Gottschalk, Alexander (ed.) (Argonne Cancer Research Hospital, Chicago, Ill.). Mar. 1969. Contract AT(11-1)-69. 146p. Dep. CFSTI.

Separate abstracts were prepared on five of the 13 sections in this report. The remaining reports deal with research projects in biochemical, physiological, and medical areas. (E.R.B.)

For abstracts of individual papers see: 35784–35786, 35814, and 35861.

35814 (ACRH-31, pp 134-43) PLUGGING OF LEAKS IN RADIUM CONTAINERS. Rozenfeld, M. L.; Mason, E. W. (Argonne Cancer Research Hospital, Chicago, Ill.).

It has been widely assumed that the absence of any radon leak indicates the absence of any holes, and further, that the existence of a radon leak indicates a hole that would enlarge in time and finally allow radium to escape. It has been found that both of these assumptions are incorrect. Holes in radium containers have frequently been found to be plugged with liquid, with the result that no detectable radon escaped. The leak rate history of several containers shows that the holes do not enlarge over a period of several years. In addition, no detectable amount of radium leaked out of doubly encapsulated containers with holes so large that the radon leak rate approached the maximum possible. Although a container that leaks radium would certainly also leak radon, findings indicate that a radon leak generally is not a precursor of a radium leak. Radon leak testing alone, therefore, will not significantly reduce the danger of a major radium spill. This can only be accomplished by a comprehensive program of radium management. The finding that liquids will plug holes in radium containers makes the detection of such holes a more difficult task. Fortunately, since there is generally no associated radium leak, plugged holes in doubly encapsulated containers are not excessively dangerous. Therefore, even though the assumptions on which present radon leak testing procedures have been based were disproved, no major modification of these procedures is indicated. (auth)

35815 (NYO-3267-6) , THERMAL AND EPITHERMAL NEUTRONS IN THE TREATMENT OF NEOPLASMS. Technical Progress Report, May 1, 1968–April 30, 1969. (Massachusetts General Hospital, Boston. Neurosurgical Service. Massachusetts General Hospital, Boston. Physics Research Lab.). Apr. 29, 1969. Contract AT(30-1)-3267. 11p. Dep. CFSTI.

Studies with surfur-containing polyhedral boranes centered upon the purification of the $B_{12}H_{11}SH^{2-}$ anion. The main goals were the isolation and purification of this anion, a determination of factors affecting the stability of this structure and how they may be controlled, and methods for maximizing the yield of this sulfhydryl-containing moiety. Boron concentrations in the blood, brain, and tumors of mice were determined, and results are tabulated. Investigations were conducted on β-hydroxyethyl and related derivatives of polyhedral boranes. A rapid analytical method for boron is described. Physical studies included measurement of parameters of the medical facility beam such as determination of depth dose distributions in tissue equivalent phantoms and development of an in vivo method of counting the alpha particles produced in the ^{10}B reaction by means of a probe having a silicon detector. The effects of the $^{10}B(n,\alpha)^{7}Li$ reaction in cultures of HeLa cells were compared to those of 250 kvp x rays by studying the colony-forming ability of irradiated cells. The calculated RBE for the alpha ray and lithium recoil particle was 3.2, whereas the RBE of the clinical application of neutron capture therapy was somewhat lower and depended upon the ^{10}B concentration in the cells. (H.L.W.)

35816 (ORAU-107, pp 6-8) RESPONSES IN CHRONIC GRANULOCYTIC LEUKEMIA TO WHOLE-BODY IRRADIATION. Andrews, G. A.; Kniseley, R. M.; Vodopick, Helen; Bergner, Per-Erik E.; Lushbaugh, C. C. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Data on patients with chronic granulocytic leukemia given 50 R or 100 R whole-body irradiation at 1.5 R/min in a ^{137}Cs medium-exposure-rate facility is discussed. In general, after six weeks, the spleen remained palpable and unchanged in size in eight patients, slightly smaller in one, and distinctly smaller in another; in the other three patients, the spleen was not palpable before or after treatment. A definite decrease in liver size was recorded in only one patient. Some degree of improvement was recorded in 10 patients. The dose of 100 R apparently produced a significantly greater depression in leukocyte count than did the 50 R dose. Thrombocytes showed a moderate but definite increase during the first two weeks after treatment with either dose. Mean hemoglobin values increased slightly during the latter part of the 6-wk period; the increase was somewhat greater after the 100 R dose. (C.O.)

35817 (ORAU-107, pp 8-12) RESPONSES TO TOTAL-BODY IRRADIATION IN CHRONIC LYMPHOCYTIC LEUKEMIA AND LYMPHOMA. Andrews, G. A.; Kniseley, R. M.; Vodopick, Helen; Bergner, Per-Erik E.; Lushbaugh, C. C. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Treatment exposures of 100 R ^{137}Cs γ radiation were given to 20 patients and 50 R exposures were given to 15 patients with chronic lymphocytic leukemia. No significant clinical responses were observed between the two groups during the first 6 weeks after treatment except that in the 100 R group, a pronounced de-

pression in thrombocyte level and an increase in the number of blood transfusions for anemic patients were noted. Twenty-two treatments of 100 R were given to 15 patients with malignant lymphoma; six patients were given 50 R doses. Evaluation of clinical responses during the first 6 weeks after treatment showed no clear difference between the 50 and 100 R group. The clinical responses of each group are discussed. (C.O.)

35818 (ORAU-107, pp 12-16) THERAPEUTIC EXPERIENCE WITH THE LOW-EXPOSURE-RATE TOTAL-BODY IRRADIATOR (LETBI). Edwards, C. L.; Lushbaugh, C. C.; Comas, Frank V.; Andrews, G. A.; Kniseley, R. M. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Whole-body ^{60}Co γ irradiation at the relatively low dose rate of 1.5 R/hr as an effective therapeutic approach to the control of some blood dyscrasias that occur during radiotherapy was evaluated. Data are tabulated and are briefly discussed. The observations appeared to demonstrate that exposure rates higher than 1.5 R/hr were required to trigger physiologic responses of nausea and vomiting in man; however, man could repair gastrointestinal physiologic systems during exposure to this low dose rate. Patient acceptance of this form of treatment was good. (C.O.)

35819 INTERSTITIAL RADIATION IN THE MANAGEMENT OF MALIGNANT DISEASE OF THE FACIAL STRUCTURES. Boyer, Carl W. Jr.; Brickner, Theodore J. Jr.; Perry, Ronald H.; Maier, John G. (Walter Reed General Hospital, Washington, D. C.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 14-19(Jan. 1969).

Interstitial radium implantation of the facial structures is a practical therapeutic procedure and is of particular value in the treatment of malignant diseases in this area which are considered to be radioresistant and prone to local recurrence after treatment. Specific indications include: inoperable lesions, to supplement the maximum tolerated dose of external irradiation and operable lesions, to deliver preoperatively a high dose of irradiation to the involved volume in the shortest possible time. The effect of this therapy on the prognosis of patients with these lesions is difficult to document because of their uncommon occurrence. The preliminary results were encouraging. (C.H.)

35820 26th CONGRESS OF JAPAN RADIOLOGICAL SOCIETY, GIFU, JAPAN, APRIL 1-5, 1967. Aoyama, Taizo; Osawa, Tadashi. Nippon Igaku Hoshasen Gakkai Zasshi, 27: 767-985(Oct. 1967). (In Japanese). (CONF-670457-(Abstr.)).

The 26th Congress of JRS was held in Gifu City from April 1 through April 5, 1967. The proceedings of the Congress are given including special lectures, symposia, and (short) reports covering the fields of radiology. The lectures included Renal Angiography by O. Olsson, and Therapie von Oberflächentumoren insebesondere des Melanoms mit schnellen Electronen by K. H. Kärcher. The symposia included the diagnosis of cancers in the upper part of the stomach, troubles in the left atrium, and the heart trouble of a left-to-right blood-flow shunt, and the planning of radiotherapy for various cancers. A total of 290 (short) reports are presented, covering phases of radiology, diagnosis, therapy and RI's for the heart, lungs, and bronchi, urinary and sexual organs, liver, bones, etc., radiation protection, radiation injuries, and (radiological) facilities. (NSA of Japan)

35821 CHEMISTRY AND APPLICATION FOR TUMOR THERAPY OF POLYHEDRAL BORANE. Watanabe, Haruyuki (Shionogi and Co., Osaka). Farumashia, 5: 21-5(Jan. 1969). (In Japanese).

A large cerebral tumor of a patient was reduced by applying boron neutron capture therapy using $Na_2{}^{10}B_{12}H_{11}SH$. Screening was performed on more than 200 kinds of boron compounds. Properties of ^{10}B related to its effectiveness for tumor therapy are discussed. $Na_2B_{12}H_{11}SH$ was the most effective compound as it was absorbed in high concentrations by tumor tissues. (NSAJ) (TSS)

35822 DIURETIC AUGMENTATION OF ^{131}I UPTAKE IN INOPERABLE THYROID CANCER. Hamburger, Joel I. (Northland Thyroid Lab., Southfield, Mich.). New Engl. J. Med., 280: 1091-4(May 15, 1969).

A method for increasing the radioiodine uptake by thyroid cancer was explored. The use of radioiodine in the treatment of inoperable cancer of the thyroid gland is compromised by the inherent limited uptake of ^{131}I. Diuretics, plus a low-iodine diet, were employed in 25 patients with inoperable thyroid cancer to produce acute iodide depletion and thus augment ^{131}I uptake by the tumor tissue. Initially, intravenous mannitol was used, but more recently oral ethacrynic acid has proved simpler, and more suitable for outpatients. Two-fold to 3-fold increases in 24-hr ^{131}I uptake were achieved in 16, lesser increases in 3, and no increase in 6 patients. This increased iodine uptake seemed to be independent of, and additional to that attributable to thyrotropin (TSH), whether endogenous by virtue of hypothyroidism or combined endogenous and exogenous. Furthermore, radioiodine taken up by the thyroid tumor tissue after diuretic preparation is well retained for at least 96 hr. Consideration of diuretic augmentation of ^{131}I uptake is justified whenever ^{131}I therapy is contemplated for inoperable thyroid cancer. (BBB)

35823 TRENDS IN RADIOTHERAPY. Deeley, Thomas J. (Hammersmith Hospital, London). Radiography, 35: 37-41 (Feb. 1969).

Various radiobiologic aspects of advances in radiotherapy are discussed including normal vs. tumor tissue differential responses, effects of radiations on cells, the oxygen effect, and chemical radiosensitizers. Some means by which the results of radiation therapy are improved and attempts to define possible trends that future work may take are outlined. In devising dose fractionation schedules, generally the more rapidly dividing are the tumor cells, the smaller should be the interval between doses; but the longer there is between doses the better chance there is of the normal tissues returning to normal. The variation in dose and time recorded in the recent literature of the treatment of carcinoma of the bronchus is shown. The dose of radiation needed to kill a certain tumor is related to the histologic nature of the growth; in general, the more anaplastic the growth, the lower the dose of radiation needed. Different survival curves for different types of tumor are shown. There may be variations in the shoulder and in the exponential slopes. The oxygen effect and the use of neutrons to irradiate anoxic tumors are considered. With neutrons the relative anoxia of the tissues is not as important as with photons produced by conventional x-ray machines. This is demonstrated from the cell survival curve. This curve showed that there is a greater biological effect with neutrons and that there is not such a difference between oxygenated and anoxic cells with neutron therapy. (BBB)

35824 PREOPERATIVE RADIATION AND RADICAL NECK DISSECTION. Strong, Elliot W. Surg. Clin. N. Amer., 49: 271-6(Apr. 1969).

Complications resulting from preoperative 18-MeV electron or ^{60}Co γ irradiation of 144 patients with head and neck cancer are reported. Irradiation was delivered to the entire neck from clavicle to mandible, chin to mastoid, via a single direct lateral port, in five equal treatments of 400 R on successive treatment days. The betatron was employed during the first 2½ years of the study. This was later supplanted by a ^{60}Co teletherapy unit, whose biological effects on the cervical tissues are similar. Surgery was carried out as soon as possible upon completion of irradiation. Several patients had significant immediate post-radiation symptoms, i.e., markedly heightened mucosal and skin reactions. More severe, late complications occurred in 65, or 42%, of the irradiated subjects. Three experienced carotid rupture. Nineteen patients developed fistulas, four of which closed spontaneously and 15 required closure. A chyle fistula developed in three additional cases. In three other patients, wound slough required secondary closure. Fewer local recurrences at the primary site occurred in the irradiated patients, but the difference was not statistically significant. Combining radiation and subsequent radical neck dissection significantly lowered the incidence of cervical recurrence, but a concurrent prolongation of survival was not produced. (BBB)

35825 RADIATION THERAPY IN THE PALLIATIVE MANAGEMENT OF PATIENTS WITH RECURRENT CANCER OF THE RECTUM AND COLON. Whiteley, Horace W. Jr.; Stearns, Maus W. Jr.; Leaming, Robert H.; Deddish, Michael R. (Memorial Hospital, New York). Surg. Clin. N. Amer., 49: 381-8(Apr. 1969).

Use of ^{60}Co teletherapy for palliation of symptoms in 165 patients with metastatic cancer is described, with special consideration of doses that would avoid radioinduced complications. In patients with liver involvement, total hepatic irradiation was utilized, except that it was occasionally possible to protect a small portion of the unaffected liver by lead shielding. The usual dose was moderate, and no attempt was made to eradicate the disease by radiotherapy. For example, in the most commonly occurring instance of pelvic irradiation, a treatment course of 2000 to 2500 rad mid-plane dose was delivered in 8 to 12 consecutive treatment days. Side effects included malaise, anorexia, and nausea. Some therapists advise the highest tolerated dose to achieve maximal antitumor effect. In theory, this may be desirable, but administration of the tissue dose maximum (6000 rad) has, it is suggested, two drawbacks. First, such doses preclude future radiation therapy to control symptoms. Sixty per cent of the patients with local disease, which in almost all instances means pelvic wall disease with pain and pressure symptoms, received more than one course of radiation therapy; many received three

courses, and 10% received more than three separately spaced courses of therapy with palliative effect. Second, the number and severity of complications increase many times when maximum doses (6000 rad) are reached. Except for a rare case, large bowel adenocarcinoma or its recurrence is not a radiocurable lesion, so that maximum dosage will rarely effect a cure. However, when radiation is used in modest dosage (2000 rad) for the relief of symptoms, a significant palliative response can be obtained. In all types and in all cases treated, 50% of patients with symptomatic recurrence received some benefit from suitably directed radiation therapy of modest dose. The use of radiation therapy in this dose range (2000 to 2500 rad per treatment course) is controversial among radiotherapists. However, it is believed that in this series it was used effectively. The avoidance of large ports and of excessive perineal irradiation is stressed in the prevention of radioinjury. (BBB)

35826 POST-IRRADIATION REACTIONS OF THE RECTUM IN PATIENTS TREATED WITH RADIUM AFTER THE MODIFIED PARIS TECHNIQUE IN THE YEARS 1957–1960. Kwasniewska-Rokicinska, Cecylia; Szelc, Stefan; Faferek, Manfred (Instytut Onkologii, Gliwice, Poland). Pol. Przegl. Radiol. Med. Nukl., 32: 107-11(Jan.-Feb. 1968). (In Polish).

The incidence of post-irradiation reactions of the rectum was studied in patients treated with radium using the modified Paris technique after surgical hysterectomy for the removal of gynecological neoplasms. In these patients, the radiotherapy was limited to vaginal applicators and the advancement of the cancer process was stage III. Among the 291 radium-treated patients the rectum reaction (proctitis) was observed in 31 patients (10.5%). Among the 326 non-operated patients with stage III neoplasms of the uterus, reactions were found in 81 patients (24.5%). Dosimetry performed in the rectum lumen in both groups did not reveal a dependence between the dose and the incidence and type of post-irradiation reactions. (auth)

35827 DOSIMETRIC PROBLEMS IN THE RADIATION TREATMENT OF THE CANCER OF THE UTERINE CERVIX. Dezsi, Zoltan; Berta, Istvan; Jona, Gabor. Magy. Radiol., 21: 96-8(Apr. 1969). (In Hungarian).

Methods of dosimetry for radiotherapy of cancer of the neck of the uterus are described that permit precision in planning of percutaneous therapy and in determining the proper dose. Dose distribution during therapy using applicators was determined in phantoms. (auth)

35828 THE POSSIBILITIES OF THE INDIVIDUAL RADIATION TREATMENT OF THE CANCER OF NECK OF THE UTERUS. Berta, Istvan; Dezsi, Zoltan; Goergey, Miklos. Magy. Radiol., 21: 99-103(Apr. 1969). (In Hungarian).

In order to assure individual and exact radiation treatment of cancer of the uterine cervix, local plastic applicators were constructed. Dose measurements performed at critical points of the lesser pelvis are tabulated. Tabulated data were used for selecting 20 kinds of plastic material for construction of the applicator. After roentgenological examination, the applicator was corrected for individual differences. After correction, parametrial radiation treatment is performed with due adjustment of the field and correct doses. (auth)

35829 MEDICAL DATA FOR THERAPY OF A 13-MeV LINEAR ACCELERATOR. THE STUDY OF LINAC THERAPY. PART I. Ozeki, Miichiro; Ono Yo (Kurume Univ., Fukuoka). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1465-78(Feb. 1969). (In Japanese).

Medical data for x-ray therapy using the LMR-13 (13 MeV) electron linear accelerator at Kurume University are discussed. (TSS) (NSA of Japan)

35830 INDIVIDUALIZED LUNG SHIELDS CONSTRUCTED FROM LEAD SHOT EMBEDDED IN PLASTIC. Maruyama, Y.; Moore, V. C.; Burns, D.; Hilger, M. T. J. (Univ. of Minnesota, Minneapolis). Radiology, 92: 634-5(Mar. 1969).

A rapid, simply constructed lung shield is described that is readily modifiable and which fulfills the requirements for a highly individualized lung shield. With minor change it can be used for any shielding problem of complex shape, involving external beam, megavoltage x ray, or γ ray therapy. Moreover, it also permits one to take account of beam divergence and differences in anterior and posterior lung block shape. Finally, it is practical and economical. Transparent cutouts of film outlines were prepared using an optical method. The tracings were transferred to a 10 cm thickness of polyethylene foam. This can then be cut with a band saw or, if beam divergence correction is necessary, by appropriately designed devices, using either a hot wire or angle blade. Once cut, the mold serves as a receptacle for pouring the lung shields. Lead, in the form of small shot, is used for the shielding material. Heated thermoplastic compound is initially and concurrently poured into the mold until the entire form is filled. Agitation aids the settling process. After setting, the form can be cut from the polyethylene, and after additional port films, minor alterations and trimming to the required shape can easily be accomplished with a band saw. (auth)

35831 THE LASER AND ITS BIOMEDICAL APPLICATION. Wear, J. O.; Williams, John (Univ. of Arkansas Medical Center, Little Rock). S. Med. J., 62: 588-92(May 1969).

Biomedical investigations of laser radiation effects are reviewed under the headings of tumor investigations, retinal studies including coagulation, dental studies, dermatologic investigations, neurologic surgery and laser effects on nerve tissue, experimental blood vessel anastomosis, cellular level studies including microsurgery, and general surgery. Effects of laser radiation in tumors have been investigated in nonpigmented and pigmented basal cell epitheliomas, squamous cell epitheliomas, malignant lymphomas, vascular tumors, melanomas, and brain tumors. Various lasers were used with varied energy densities and pigmentation by dyes was also tried. Varying degrees of success were obtained for the varied conditions. A possible hazard in laser treatment of brain tumors is the creation of ultrasonic waves. Before the optical effects of the laser are perceptible, waves of the order of 200 to 300 Kcps are emitted. In sensitive tissue such as the brain, these effects are not negligible. The laser has been used to create a totally nonocclusive vascular anastomosis to improve blood flow to vital organs. In pigmented tissues an increase in free radical concentrations is detected, and the progressive necrosis from the target area may indicate chemical changes that are not thermal effects. The interaction of the laser beam at high energies with tissue may result in an exploding effect. The possible hazards of laser radiation to personnel are considered. Eye protection should be provided by goggles with sufficient protective material and fitted in a manner to prevent light from entering at any angle. (BBB)

35832 TREATMENT OF HYPERTHYROIDISM. Miller, J. Martin (Henry Ford Hospital, Detroit). New Engl. J. Med., 280: 508(Feb. 27, 1969).

Problems encountered in the use of large doses of radioiodine (^{131}I) in the treatment of toxic multinodular goiter are briefly discussed, particularly the difficulty of determining the magnitude of the dose. The author treated 26 patients with 20 to 100 mCi. Only ten were euthyroid after a single dose, four received 50 mCi and were hyperthyroid 2 to 5 months later when lost to follow-up observation, and two died with vascular accidents within one week after receiving 50 and 100 mCi. Another late recurrence of hyperthyroidism was observed in a 78-yr-old woman 10 yr after a total dose of 60 mCi of radioiodine. (BBB)

35833 TUMOR BED EFFECT OF IONIZING IRRADIATION IN EXPERIMENTAL CANCER OF THE COLON. O'Brien, Paul H.; Sweitzer, Caesar; Sherman, Joseph O.; Moss, William T. (Northwestern Univ. Medical School, Chicago). Cancer, 23: 451-4 (Feb. 1969).

Ionizing irradiation was given to the surface of the abdomen of New Zealand white rabbits. The dose was 988 rads. Celiotomy and implantation of the V-2 carcinoma into the colon of the animals was accomplished 1 week following irradiation. There were 23 animals in the experimental group and 21 animals in the control group. The animals which received irradiation prior to implantation of the V-2 had an average survival time of 49 days. The average survival time of the animals which had not received irradiation prior to implantation of V-2 carcinoma was 32 days. The probability of this observed difference between the two groups of animals occurring by chance is less than 0.0004. (auth)

35834 NASAL TUMOR RESPONDS BEST TO RADIATION INSTEAD OF SURGERY. J. Amer. Med. Ass., 209: 29(July 7, 1969).

In a series of clinical tests, it was found that juvenile nasopharyngeal angiofibromas responded to radiotherapy even where previous surgical techniques had failed. The use of angiography for diagnosis rather than routine diagnostic films has resulted in a higher complete remission rate. Total tumor doses of 3,000 rads over a three week period were sufficient to bring about remission. There were no complications and little morbidity resulting from the use of radiotherapy. (E.R.B.)

35835 ANALYSIS OF 40 CASES TREATED BY TOTAL THORACIC IRRADIATION. Newton, K. A.; Spittle, Margaret F. (Westminister Hospital, London). Clin. Radiol., 20: 19-22(Jan. 1969).

Forty patients with widespread pulmonary metastases have been treated by total thoracic irradiation, mostly to a center dose of 2000 R to 2500 R at approximately 150 R daily. Complete regression of disease was achieved in 15 cases and useful

palliation achieved in a further 15 cases with no complications, haematological or otherwise, attributable to the treatment. (auth)

35836 MEGAVOLTAGE TECHNIQUE FOR THE TREATMENT OF CARCINOMA BREAST. Garrett, M. J. (Regional Radiotherapy Centre, Liverpool). Clin. Radiol., 20: 110-11(Jan. 1969).

A technique for irradiating carcinoma of the breast, using 2 opposing 4 MeV x-ray beams is described. Comparison of different treatment schedules shows that the complication rate is reduced by lowering the dose to 5000 rads in 4 weeks with no deterioration in the survival rate. (auth)

35837 CASE OF CHONDROSARCOMA WITH PULMONARY AND SKELETAL METASTASES AFTER HEMIPELVECTOMY, SUCCESSFULLY TREATED WITH ^{35}S-SULFATE. Bostroem, Harry; Edgren, Bo; Friberg, Ulf; Larsson, K. Sune; Nilsonne, Ulf; Wengle, Bo; Wester, Per Olof (Serafimerlasarettet, Stockholm). Acta Orthop. Scand., 39: 549-64(1968).

A new method of treatment of chondrosarcoma was developed that is based on the introduction of a radioactive precursor which, when built into the sulfated glycosaminoglycans, causes damage to the malignant cells. A case of chondrosarcoma, with pulmonary and skeletal metastases occurring after hemipelvectomy, is described in which treatment with ^{35}S-sulfate was successfully applied. The total dose was 1.735 Ci and is the highest in humans thus far reported. The isotope was given in 7 separate injections of 235 to 250 mCi each by various intra-arterial and intravenous routes during a period of 7 months. Strict precautions were taken to reduce the hazards of undue isotopic contamination. Routines normally employed in cases of highly infectious diseases were used in the general management of the patient for at least 10 days after each single dose of ^{35}S-sulfate. Urine was collected and sent to a facility for the handling, assay, and disposal of the high level of radioactivity. A biopsy showed the characteristic, chondrosarcomatous appearance of the tibial metastasis before treatment with ^{35}S. Ten months later it was strikingly different. There was marked sclerosis and hyalinization of the tissue. The tumor seemed to be completely devitalized, and there were no signs of viability among the few remnant tumor cells. Studies on the peripheral blood including determination of the number of erythrocytes, leukocytes, and thrombocytes, as well as hemoglobulin concentration, showed that the hematologic complications were not serious. On two occasions during the treatment the hemoglobin level dropped to values around 9 g/100 ml. The erythrocyte and thrombocyte counts remained at safe levels, with the lowest values 1 month and 4 months after initiation of ^{35}S therapy. The leukocyte count was more strongly influenced by the ^{35}S treatment, and fell to 1200 cells/mm^3 after 6 weeks of treatment, at which time 1 Ci of radioactivity had been given. Myelopoietic tissue was found to be hypoplastic, with the occurrence of numerous damaged cells. The treatment did not cause any other serious damage to the bone marrow, nor were there any signs of damage to other tissues or any symptoms of generalized radiation sickness. (BBB)

Blast and Thermal Effects

35838 THYROID CARCINOMA IN HIROSHIMA AND NAGASAKI. I. PREVALENCE OF THYROID CARCINOMA AT AUTOPSY. Sampson, Richard J. (Atomic Bomb Casualty Commission, Hiroshima); Key, Charles R.; Buncher, C. Ralph; Iijima, Soichi. J. Amer. Med. Ass., 209: 65-70(July 7, 1969).

Carcinoma of the thyroid at autopsy was found to be far more frequent in Japan than in any recorded American series. In 3,067 consecutive autopsies from the fixed population sample of the Japanese National Institute of Health-Atomic Bomb Casualty Commission Life-Span Study in Hiroshima and Nagasaki, 536 primary thyroid carcinomas were found; 97% were occult papillary. The prevalence was significantly higher in women and those exposed to 50 rads or more of direct atomic radiation. The prevalence rate in the 1,096 persons in this study with no radiation dose whose entire thyroid gland was examined was 17.9% compared to 1.0% to 4.0% in the American series. Radiation, method of examination, diagnostic criteria, and bias in autopsy selection did not appear to explain the observed high frequency of thyroid carcinoma at autopsy. (auth)

Radiation Effects on Animals

Refer also to abstracts 35184, 35639, 35668, 35693, 35774, 35908, 35918, and 35954.

35839 (AD-682427) KIND OF PURE DEATH PROCESS FROM LETHAL IONIZING RADIATION. Pao-han, Wang. Translated from Wei Sheng Wu Hsueh Pao, 9: 201-2(1963). 9p. (FTD-HT-23-205-68). CFSTI.

The effects of ionizing radiation on lining cells are discussed in terms of target theory. The limitations of the theory do not permit its application to all radioinduced biological effects. However, the application is determined by the following three conditions: Increases of radiation dose require that the survival curve should be an exponential one when lethality is investigated; the effect of definite dose and the dose intensity in action are possibly independent of its distribution type; the effect of primary ionization is independent of the wavelength or type of radiations. (USGRDR) (TSS)

35840 (AEC-tr-7013) RADIOBIOLOGY. Translation of Radiobiologiya, 8: No. 6, 787-951(1968). 232p. Dep. CFSTI.

Papers within the scope of NSA were abstracted from the original language and have appeared in previous issues. (H.G.D.)

35841 (ORAU-107, pp 42-4) THE RADIOSENSITIVITY OF RAT BONE-MARROW CELLS, IRRADIATED IN VITRO. Comas, Frank V. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

A survival curve was obtained for rat bone-marrow cells irradiated in vitro. Suspended cells were ^{137}Cs γ-irradiated and then injected into irradiated rats. Twelve days after irradiation, recipient rats were killed and the number of spleen colonies was counted. Results were very close to those obtained by irradiating bone marrow cells in vivo. The effectiveness of radiation in killing cells in the rat and the mouse is compared. (C.O.)

35842 DEOXYRIBONUCLEIC ACID (DNA) REPAIR REPLICATION OF ULTRAVIOLET (UV) IRRADIATED NORMAL AND LEUKEMIC LEUKOCYTES. Frey-Wettstein, M.; Longmire, Robert; Craddock, C. G. (Univ. of California School of Medicine, San Francisco. Veterans Administration Center, Los Angeles). J. Lab. Clin. Med., 74: 109-18(July 1969).

The labeling of leukocytes with tritiated thymidine (^{3}HTdR) after irradiation with uv light is discussed. Such labeling involves repair replication of DNA damage caused by the irradiation. It was found that cells having the capacity to divide again incorporated the radioactive label more consistently than other cells. End stage cells such as mature granulocytes probably lack the necessary enzyme systems for excision and repair of the uv-radioinduced DNA injury. Special study was made of the lymphocytic population in different areas of the lymphatic system, with the objective of comparing repair replication in short- and long-lived varieties. It was shown that 75 to 80% of the peripheral blood small lymphocytes and 85 to 90% of the lymph node lymphocytes exhibit the capacity to repair the uv-radioinduced DNA breaks, while only 20 to 30% of thymus small lymphocytes incorporate the label. Thymus small lymphocytes were regarded as short-lived end cells. (auth)

35843 EFFECTS OF BIOLOGICALLY ACTIVE SUBSTANCES, ISOLATED FROM THE LIVER OF IRRADIATED RATS, ON THE SYNTHESIS OF DNA IN HeLa CELLS. Kalendo, G. S.; Merkulov, A. S.; Kuzin, A. M. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR, 184: 715-18 (Jan. 21, 1969). (In Russian).

The synthesis of proteins, RNA, and DNA in cells of HeLa cultures is enhanced by low concentrations of biologically active radiotoxins separated from irradiated plants. In this connection, the specific nature of the activation of the synthesis was examined, using instead of the vegetable radiotoxin, a biologically active material prepared from the liver of rats exposed to 1000 R of γ radiation. Chromatographic examination of the extract revealed the existence of 2 peaks, one of which contained polarographically active materials. The most active fraction was used in a culture of HeLa cells, studying the DNA synthesis by radioautography, on the basis of incorporation of ^{3}H-thymidine. The results showed that action of the greatly diluted extract for 5 minutes strongly enhanced the DNA synthesis. This is due to the increased DNA synthesis in the cells in the S state and the increase of the number of synthesizing cells. (TTT)

35844 EFFECT OF IONIZING RADIATION ON THE MATURING RATE OF THE RETICULOCYTES OF MAMMALS. Samardakova, A. G.; Strzhizhovskii, A. D. (Inst. of Medico-Biological Problems, Moscow). Dokl. Akad. Nauk SSSR, 184: 719-21 (Jan. 21, 1969). (In Russian).

The replacement of aging cells in the tissues by young ones was studied by examining the effects of radiation on the maturing cells of mammals during the latter stages of erythropoiesis. Maturing of reticulocytes is accompanied by degradation of mitochondria and depletion of RNA and the Krebs-cycle enzymes; the cells also lose their ability to participate in the oxidative phosphorylation and the synthesis of hemoglobin. The experiments were carried out with normal rats and with animals tested with phenylhydrazine exposed to 700 Rad of γ radiation. Blood samples were taken immediately

after irradiation, during the recovery period, 7 to 14 days later, and up to 2 months after exposure. Maturing of the erythrocytes was determined by in vivo cultures. Tests with animals rendered anemic showed that the maturing period became longer. The radiosensitivity of the cells was found to decrease with their maturation. The results indicated that radiation injury of the erythrocyte cells of the bone marrow suddenly slows down the maturing of their descendents: during the recovery period, the maturing rate was 7 times lower than that of specimens from normal rats. In about 1½ months, the mean maturing time was reduced to about 35%. Thus the effect is conserved in successive generations; it might be due to a genetic metabolic insufficiency. (TTT)

35845 EFFECTS OF CAFFEINE ON ULTRAVIOLET-IRRADIATED MOUSE L CELLS. Domon, M.; Rauth, A. M. (Univ. of Toronto). Radiat. Res., 39: 207-21(July 1969).

Incubation of mouse L cells in the presence of 2 mM caffeine immediately after uv irradiation caused a decrease in their colony-forming ability, compared to cells incubated in the absence of caffeine. To better understand this phenomenon, a study was made of the effect of caffeine on cell progression and DNA synthesis in unirradiated cells and uv-irradiated cells. Unirradiated cells grew and proliferated in the presence of 2 mM caffeine, though it did cause small delays in the progression of G_1 cells to S phase and G_2 cells to mitosis and increased the doubling time of such cells from 16 hr to 18 to 20 hr. After low exposure of uv irradiation (100 ergs/mm^2 or less), caffeine caused a specific block in the progression of uv-irradiated cells through S phase. Caffeine did not cause any additional delay in the progression of cells irradiated in G_1 phase to S phase or in cells irradiated in G_1 phase to mitosis. The number of cells stopped in S phase by the presence of caffeine were quantitatively correlated with the loss of cell colony-forming ability. These studies indicated that caffeine acts specifically in S phase. Possible models for its mode of action are discussed. (auth)

35846 EXPERIMENTS WITH TISSUE CULTIVATION IN VIVO FOR THE STUDY OF THE REGENERATIVE CAPACITY OF THE SPLEEN FOLLOWING EXPOSURE TO RADIATION. Georgiev, I.; Colakov, Hr. (Hohes Medizinische Institut, Plovdiv, Bulgaria). Folia Med. (Plovdiv), 9: 71-8(1967). (In German).

The regenerative capacity of the spleen separated from white rats and exposed to 1500, 2000, 5000, and 10,000 R of x radiation was investigated. Small sections of the spleen were placed in microporus chambers and cultivated for 5 to 10 days in the abdominal cavities of intact rats. Various effects observed following the exposure to 5000 and 10,000 R were induced by direct radiation damage. A high radioresistance of the recticular cells and fibroblasts was confirmed by experiments. Various methods for studying reactions between cells and tissues following irradiation are discussed. (tr-auth)

35847 EFFECT OF LASER BEAMS ON THE GROWTH OF EHRLICH ASCITES TUMOUR. PRELIMINARY COMMUNICATION. Mester, E.; Sellyei, M.; Tota, G. J. (Univ., Budapest). Arch. Geschwulstforsch., 32: 201-6(1968). (In German).

Ehrlich ascites tumor cells were irradiated by laser beams of low energy (1 J/cm^2 or less). Tumors arising from intraperitoneally inoculated irradiated cells grew faster than tumors not irradiated before inoculation. This may be explained by the elevated index of mitosis in laser irradiated tumors. (tr-auth)

35848 SOME PHYSICO-CHEMICAL APPROACHES TO RADIATION BIOLOGY. Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 353-60 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Previous observations of lethality after whole-body irradiation of mammals led to the realization that the major part of whole-body-irradiation effects could be understood in terms of cellular radiobiology. Lethal effects in the whole organism can be explained by cellular depopulation of specific organs which, in consequence, become limiting for survival of the whole organism. It has become apparent that damage to individual molecules is the limiting factor in the survival of cells. The subject is discussed under the following headings: the chemical approach; biological material for chemical investigation (the dry system; the wet system; radiation chemistry of phage); chemical structure relevant to radiobiology (nucleic acid, polyglutamic acid, proteins). (UK)

35849 POTENTIALLY LETHAL RADIATION DAMAGE: REPAIR BY MAMMALIAN CELLS IN CULTURE. Belli, James A.; Shelton, Merijean (Univ. of Texas Southwestern Medical School, Dallas). Science, 165: 490-2(Aug. 1, 1969).

Less than optimum conditions with regard to cell division after x irradiation provide the necessary environment in which mammalian cells can repair potentially lethal radiation damage. The kinetics of repair suggest that, during the repair process, a transient, unstable cellular state occurs that prevents cell division in complete growth medium. The capacity for repair appears to be dependent on cell age. (auth)

35850 RADIATION LEUKEMIA VIRUS: QUANTITATIVE TISSUE CULTURE ASSAY. Fischinger, Peter J.; O'Connor, Timothy E. (National Cancer Inst., Bethesda, Md.). Science, 165: 306-9((July 18, 1969).

Radiation leukemia virus does not propagate in tissue cultures from either Swiss or C57BL mouse embryos, but it does augment focus formation by the defective Moloney leukemia pseudotype of murine sarcoma virus in Swiss mouse cells and thus can be quantitatively assayed. (auth)

35851 CHANGES INDUCED BY ACTINOMYCIN IN THE EFFECT OF X RAYS ON CELLS OF EHRLICH'S ASCITES TUMOR. Casanello, Delia; Valencia, J. I. (Univ., Buenos Aires). Rev. Soc. Argent. Biol., 43: 74-83(Apr.-July 1967). (In Spanish).

The action of Actinomycin D (1 μg/ml) in pre- and post-treatments of x-irradiated Ehrlich ascites tumor (subline ELD) cells was studied. The effects observed were mitotic inhibition chromosome aberrations and cell death. The most radiosensitive stage of the DNA cycle was G_2. Treatments with Actinomycin alone or combined with 500 R (especially as pretreatment) modified the DNA cycle very little. The chemical alone did increase chromosome aberrations significantly. These effects might be due to the inhibition of RNA synthesis or to mechanical disturbances of the chromosome. The breaks decrease when the chemical is applied as posttreatment and the lack of action, when used as pretreatment, on G_2 and S cells could be explained as an alteration of DNA level, either chemical or mechanical, or else as a decrease in the synthesis of proteins needed for the restoration process. Both mechanisms, combined or isolated, would eliminate the most damaged cells. (C.O.)

35852 EFFECT OF 300 R X-RAYS ON INCORPORATION OF ^{3}H-THYMIDINE IN NON-DIVIDING DIFFERENTIATED CELLS. Pelc, S. R. (King's Coll., London). Int. J. Radiat. Biol., 15: 175-9(1969).

The basic effects of a single, 300 R dose of x rays on the incorporation of tritium-labeled thymidine in non-dividing, fully differentiated cells (seminal vesicle, liver, heart, muscle, small intestine) of mice were investigated. The differences between the effects of a moderate single dose in vivo on DNA synthesis in populations of dividing cells and of non-dividing cells were as follows: Depression to ~0.5 of the control value versus depression to a few percent, persistence of the minimum for a few hours versus depression for two days, and fast recovery with over-shooting versus slow recovery that was still incomplete after 13 days. Therefore, it was shown that the uptake of tritium-labeled thymidine was depressed to a few percent of control values after a 300 R dose of x rays and that recovery was still incomplete after 13 days. (C.O.)

35853 BIOLOGICAL EFFECTIVENESS OF HIGH-ENERGY PROTONS. Cercek, Lea; Ebert, M.; Gilbert, C. W.; Haigh, Mary V.; Howard, Alma; Massey, J. B.; Potten, C. S. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 15: 137-56(1969).

Three biological test systems have been used to compare the effectiveness of 380 MeV protons and ^{60}Co γ rays or 300 kVp x rays in killing cells. Reduction in growth of the coleoptile and first leaf of barley seedlings after irradiation of dry seed gave a proton/γ-ray RBE of ≈1.3. Loss of viability of fern spores irradiated in the dormant state also indicated a greater effectiveness of protons than of γ rays. Absence of melanocytes in hair follicles of mice irradiated at a previous telogen stage gave a proton/x ray RBE of 1.4. The general conclusion is that 380 MeV protons are about 1.3 times as effective as x or γ rays in killing cells, and the implications for the permissible exposure of man to high-energy protons are discussed. (auth)

35854 RESPONSE OF MOUSE L-P59 CELLS TO X-IRRADIATION IN THE G_2 PHASE. Thompson, L. H.; Humphrey, R. M. (Univ. of Texas, Houston. Texas Medical Center, Houston). Int. J. Radiat. Biol., 15: 181-4(1969).

Populations of mitotic L-P59 cells were x irradiated at 1000 rads. Survival curves were obtained for cell populations at 3.5 hr (early G_1), 13 hr (mid-S), and 18 hr (G_2). Cells irradiated in early G_1 (3.5 hr) were the most resistant. At 13 hr the S phase was more sensitive than G_1. The following conclusions were made with respect to the age-response function of x-irradiated mouse L-P59 cells: G_2 is a more sensitive phase than either G_1 or S, although the G_2 survival curve had a definite shoulder. After

a resistant period in early and mid-G_1, the cells became increasingly sensitive as they progressed toward mitosis. Mitotic cells were sensitive, perhaps even more sensitive than G_2 cells. (C.O.)

35855 SURVIVAL OF MOUSE TYPE-B SPERMATOGONIA FOR THE STUDY OF THE BIOLOGICAL EFFECTIVENESS OF VERY HIGH-ENERGY NEUTRONS. Bianchi, M. (Istituto Superiore di Sanita, Rome); Quintiliani, M.; Baarli, J.; Sullivan, A. H. Int. J. Radiat. Biol., 15: 185-9(1969).

The suitability of the survival of type B spermatogonia in mice as a system for estimating the biological effectiveness of high-energy neutrons was investigated. Preliminary measurements made in a nominal 400 MeV neutron beam from the CERN 600 MeV synchrocyclotron are reported. Results of the investigation of dose-rate dependence for x rays and ^{60}Co γ radiation are presented in tabular form; a high degree of reproducibility and dose-rate independence as well as no other differences were noted. The preliminary evaluation of the relative biological efficiency of the 400 MeV neutron beam, using an estimated value for the LD_{50} dose and comparing it with the x and ^{60}Co γ ray results gave values of 3.7 for the pure beam and 2.7 at maximum build-up. A discussion of these results was not presented. It was concluded, however, that the system chosen was well suited both with respect to radiosensitivity and reproducibility to allow a study of the biological effectiveness of nuclear interaction processes from high-energy radiation. (C.O.)

Invertebrates

Refer also to abstracts 35558, 35666, 35687, 35694, and 35696.

35856 EFFECTS OF HIGH-TEMPERATURE ON SURVIVAL OF IRRADIATED MEDFLY PUPAE (CERATITIS CAPITATA W.). Katiyar, Kamta P.; Ferrer, Francisco (Entomologo Asociado y Entomologo Ayudante, Turrialba, Costa Rica). Turrialba, 17: 31-4(Jan.-Mar. 1967). (In Spanish).

X-irradiated (10 KR) and normal Medfly pupae were incubated for 2, 4, 6, and 8 hr at temperatures of 25. 30, 40, and 45°C, and 60 to 85% relative humidity. Adult emergence was normal up to 40°C. Exposure to 45°C for two hr or longer was lethal to irradiated as well as normal pupae. A heat treatment of 40°C for 8 hr immediately after irradiation had no latent adverse effect on the longevity of the adults. Irradiated females survived longer than normal females. (auth)

35857 A COMPARATIVE RADIOSENSITIVITY OF TWO STRAINS OF AMOEBA PROTEUS. Kalnii, V. S. (Inst. of Cytology, Leningrad). Tsitologiya, 11: 68-71(June 1969). (In Russian).

Radiosensitivity sharply differs in two strains of Amoeba proteus (B and C). The LD_{50} is 25 to 30 and 140 to 180 kRad, respectively. In addition, C differs from B as concerns the immediate response to the irradiation, the delay in division or the death without division. The difference in the radiosensitivity of these two strains does not correlate with their previously reported (Yudin, 1967) equally high resistance to several non-irradiation agents which may be due to some different genetic basis underlying radiosensitivity and sensitivity to non-radioactive agents. (auth)

35858 COMPARISON OF EFFECTS OF IRRADIATION ON THE PRIMARY SPERMATOGONIA AND MATURE SPERM OF THREE SPECIES OF DIPTERA. Riemann, John G.; Thorson, Barbara J. (Agricultural Research Service, Fargo, N. Dak.). Ann. Entomol. Soc. Amer., 62: 613-17(May 1969).

X-ray doses of 2500, 5500, and 8500 R were required to stop sperm production permanently by destroying primary spermatogonia in the house fly, Musca domestica L.; the black blow fly, Phormia regina (Meigen); and the secondary screw-worm, Cochliomyia macellaria (F.), respectively. These doses did not correlate closely with the doses required to sterilize males of the three species by inducing dominant lethal mutations in mature sperm. Some testes with no recognizable surviving spermatogonia still contained what appeared to be somatic cells that were undergoing replication 2 weeks posttreatment. (auth)

35859 X-RAY RADIATION EFFECTS ON SURVIVAL AND STERILITY OF ADULTS OF THE CEREAL LEAF BEETLE. Myser, Willard C.; Carey, Walter E. (Ohio State Univ., Columbus). J. Econ. Entomol., 62: 543-50(June 1969).

X-ray irradiations of adult Oulema melanopus (L.) were performed with a 250-kv constant-potential x-ray machine. Survival percentages of 20 through 80% were measured in the exposure range of 0-8000 R. Only a slight difference in radiation sensitivity between the sexes was observed, but increased survival of both control and irradiated beetles was demonstrated by laboratory-reared stock when compared with corresponding groups from field collections. Sterilization exposure of 5000 R and 3000 R was measured for males and females, respectively. (auth)

35860 THE INFLUENCE OF γ-IRRADIATION UPON THE POPULATION DYNAMICS AND SEX RATIO IN MODEL POPULATIONS OF DROSOPHILA MELANOGASTER. Surabyan, A. S. (Inst. of Medical Radiology, Obninsk, USSR). Zh. Obshch. Biol., 30: 374-6(May-June 1969). (In Russian).

The influence of γ irradiation upon the population dynamics and sex ratio in model populations of Drosophila melanogaster was studied. Three series of experiments were carried out: controls, permanent radiation (500 R per generation), and simultaneous radiation (5,000 R). Populations in all series did not differ in the level of quantitative stabilization. Populations of the later series more noticeably declined from the check ones during the first 4 to 5 generations, but afterwards no difference was observed. The sex ratio was stabilized simultaneously with the quantitative stabilization of populations and was shifted to females with the ratio 1.1 : 1. (auth)

Vertebrates

Refer also to abstracts 35633, 35635, 35636, 35638, 35641, 35642, 35644, 35646, 35649, 35650, 35660, 35661, 35670, 35674, 35676, 35678–35681, 35687, 35723, 35766, 35768, 35769, 35771, 35773, 35776, 35777, 35780–35783, 35844, 35852, and 35946.

35861 (ACRH-31, pp 45-53) DEPTH DOSE STUDIES IN ELECTRON BEAM THERAPY: EFFECTS ON ANAGEN MOUSE HAIRS. Lanzl, L. H.; Malkinson, F. D.; Ahrens, T. J. (Argonne Cancer Research Hospital, Chicago, Ill.).

Experiments were undertaken to help elucidate the skin-sparing effects that were observed when high-energy electrons were used for cancer therapy. The term implies that a higher dose of electrons is required to produce the degree of erythema caused by exposure to 200 kv x rays, or alternatively, that there is a less intense skin reaction to electrons, compared with conventional x rays, when the radiation response of the underlying tumor is the same. Factors involved in this phenomenon include anatomic location of the treatment field; field size; instantaneous dose rate; pulse; average dose rate; dose level and fractionation schedule; scattering of the electron beam with its effect on the energy spectrum; collimation and/or scanning techniques; and dose build-up as a function of depth immediately beneath the surface. A study of the build-up factor is described, utilizing physical and biological systems of dosimetry for an electron beam therapy unit known to produce the skin-sparing effect. (E.R.B.)

35862 (AD-680740) EFFECT OF HEAD VERSUS TRUNK FISSION-SPECTRUM RADIATION ON LEARNED BEHAVIOR IN THE MONKEY. Report for November 1967–February 1968. Chapman, Paul H.; Young, Robert J. (School of Aerospace Medicine, Brooks AFB, Tex.). Aug. 1968. 17p. (SAM-TR-68-80). CFSTI.

Twenty-two Macaca mulatta monkeys, trained to a discrete avoidance task, were divided into three groups for exposure to either head only, trunk only, or whole-body radiation with a pulsed mixed γ and neutron fission source. A total dose of 6,250 rads was delivered in a 20-msec pulse. Trained behavior and blood pressure were monitored continuously during the first hr postirradiation. Results indicate that head or trunk irradiation will produce deterioration in performance; early performance decrement results primarily from a direct effect of radiation on cephalic structures; this head effect is dose-rate dependent; trunk effects are significant in producing a more uniform early decrement and a more severe later decrement; and the hypotensive response seen immediately after whole-body radiation is secondary to radiation effects within the trunk. (auth) (TAB)

35863 (AD-680746) BEHAVIORAL AND PHYSIOLOGIC RESPONSES OF MACACA MULATTA MONKEYS TO SUPRALETHAL DOSES OF RADIATION. Report for September 1966–January 1967. Young, Robert J.; Chapman, Paul H.; Barnes, Donald J.; Brown, G. Carroll; Hurst, Charles M. (School of Aerospace Medicine, Brooks AFB, Tex.). Sept. 1968. 30p. (SAM-TR-68-73). CFSTI.

Eighteen primates (Macaca mulatta) were trained to a multiple avoidance program (MAP). Tasks requiring visual, auditory, and tactile discriminations were included in this program. Thirteen behavioral and three physiologic variables were analyzed for radiation effects at dose levels of 2,500, 3,750, and 5,000 rads up to one hour after mixed γ and neutron irradiation. The analysis of all variables demonstrated a significant change across time (irradiation effect). When an analysis of variance was accomplished, no significant statistical differences were found between dose levels for any of the variables examined in this paper,

possibly because of the small number of subjects per group. In two future reports the data examined in this experiment will be compared with subsequent data gathered on the identical variables and dose levels at differing dose rate and neutron-gamma ratios. (auth) (TAB)

35864 (AD-681037) THE ACUTE MORTALITY RESPONSE OF BEAGLES TO PULSED, MIXED GAMMA–NEUTRON RADIATIONS. Pitchford, T. J.; Thorp, J. W. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). June 1968. 22p. (AFRRI-SR-68-15). CFSTI.

Eighty-one beagle dogs were exposed unilaterally to mixed γ-neutron radiations from the AFRRI-TRIGA reactor. Nine groups received midline tissue doses ranging from 155 to 236 rads. Radiations were delivered in a single pulse with 80 percent of the dose delivered in less than 70 milliseconds. The LD50/60 was 210 rads. Survival times ranged from 10 to 25 days, and the mean was 16.5 days. The radiation effects were most prominent between 10 and 25 days post exposure. (auth) (TAB)

35865 (AD-681070) VISUAL ACUITY PERFORMANCE OF NORMAL AND CHRONIC FOCAL-HEAD IRRADIATED MONKEYS. McDowell, A. A.; Brown, W. Lynn (Texas Univ., Austin. Radiobiological Lab.). Dec. 1968. 5p. (SAM-59-5). CFSTI.

Monkeys were tested on each of eight visual acuity problems presented in order of increasing difficulty. The results of the study reflected differences between chronic focal-head x irradiated monkeys and normal monkeys with respect to performance on these problems. Most efficient performance was shown by the control animals, intermediate efficiency of performance by the animals with previous focal-head irradiation of the posterior association areas, and least proficient performance by the animals with previous focal-head irradiation of the frontal association areas. (auth) (TAB)

35866 (AD-681072) VISUAL ACUITY PERFORMANCE OF NORMAL AND CHRONIC IRRADIATED MONKEYS. Brown, W. Lynn; McDowell, A. A. (Texas Univ., Austin. Radiobiological Lab.). Nov. 1958. 5p. (SAM-58-149). CFSTI.

Six normal, 10 low-dose irradiated (77 to 154 rep), nine intermediate-dose irradiated (308 rep), and four high-dose irradiated rhesus monkeys (616 rep) were tested to a criterion of 21 correct responses (24 trials a day) for two successive days on each of eight visual acuity problems presented in order of increasing difficulty. Each problem required the subject to choose between circles and circles with breaks in order to procure a food reward. Previous visual acuity testing had shown a deficit only in the high-dose irradiated group during the first year following mixed γ and neutron radiation exposure to which the experimental animals were subjected three yr prior to the initiation of the present study. The results of the present study demonstrated that the visual acuity deficit noted during the first year after exposure in the high-dose irradiated monkeys (616 rep) was still manifested three yr after exposure; and monkeys in the intermediate-dose group (308 rep), that had shown no visual acuity deficit during the first year after exposure, manifested such a deficit three yr after exposure. An interpretation of the results in terms of a basic deficit in learning ability for the monkeys of these two groups is contraindicated by their superiority over normal and low-dose irradiated monkeys on the initial and easiest problem. (auth) (TAB)

35867 (AD-681073) NOVELTY LEARNING SETS IN RHESUS MONKEYS. Brown, W. Lynn; Overall, John E.; Blodgett, H. C. (Texas Univ., Austin. Radiobiological Lab.). Nov. 1968. 5p. (SAM-58-147). CFSTI.

Thirty-three rhesus monkeys, seven normal, 13 given low-dose radiation, and 13 given high-dose mixed γ and neutron radiation, were presented with 12 object-quality discrimination problems each day for 16 days. Four trials were allowed on each problem. Each problem involved one new or novel stimulus and one stimulus which had appeared in the preceding problem. Half the time, the stimulus brought forward had been positive (rewarded) and half the time negative (nonrewarded) in the preceding problem. In each problem, the new or novel stimulus was made positive (rewarded) and the stimulus retained from the preceding problem, regardless of previous sign, became negative. The monkeys attained significant first-trial solution of the successive problems. Previous exposure to whole-body radiation did not produce significant differences in performance in this experiment. A significantly greater likelihood of error resulted when the positive stimulus was retained with reversed sign than when the negative stimulus was retained without reversed sign. The relative difficulty of the positive-brought-forward with reversal and the negative-brought-forward without reversal was found to depend on the degree of training. (auth) (TAB)

35868 (AD-682794) REMOTE REACTIONS OF HEMATOPOIETIC TISSUE TO PROTON AND X-RAY IRRADIATION IN COMBINATION WITH G-FORCES. Zharova, E. I.; Khrustalev, S. A.; Protasova, T. G.; Davydov, B. I.; Antipov, V. V. Translated from Izv. Akad. Nauk SSSR, Ser. Biol., 32: 290-6(1967). 14p. (FTD-HT-23-69-68). CFSTI.

The remote reactions of hematopoietic tissue to the combined effects of x rays or protons and acceleration (G forces) were studied in mice of both sexes, exposed to six different combinations of irradiation and centrifugation. Some of the animals died within two months; the balance were kept under observation for 2 years. Mice displaying hematopoietic disturbances were killed for morphohistological study. Karyological studies (Ford's and Fox's methods) were made of bone marrow and spleen cells of 14 mice showing symptoms of leukosis and leukemia at various time intervals after exposure. The results show that protons, like x rays, are a leukemogenic (blastomogenic) factor. Mice are very sensitive to G forces; many died shortly after exposure, while the survivors displayed increased susceptibility to infectious disease. These effects were especially pronounced when G forces were combined with x rays, and less severe when G forces were combined with protons. (USGRDR)

35869 (JPRS-47582, pp 29-35) IMPAIRMENT OF CELL DIVISION IN BONE MARROW OF RATS IRRADIATED BY 50-MeV PROTONS. Govorun, R. D. Translated from Kosm. Biol. Med., 2: No. 6, 21-5(1968).

The processes of cell division and depletion of bone marrow of rats exposed to whole-body irradiation by 50-MeV protons were studied. The irradiation was shown to disturb mitotic activity and division of bone marrow cells and to cause destructive changes. The changes in mitotic activity and number of aberrant mitoses and cells with nuclear destruction were observed for seven days after the exposure. The dose dependence of the number of aberrant cells and the value of the mitotic index were investigated one day after irradiation. A linear dose dependence of the number of aberrant mitoses was established for the dose range 100 to 550 rad. No significant differences were observed between the biological effect of 50-MeV protons and ^{60}Co γ rays. The relative biological effect is 1 or somewhat greater for the analyzed tests. (auth)

35870 (RD/B/N-1356) BIOLOGICAL ASPECTS OF SKIN IRRADIATION. PART I. PRELIMINARY INVESTIGATIONS. Whitton, J. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Apr. 1969. 27p. Dep.

The biological aspects are reviewed in order to provide a background for further studies intended to clarify the relationships between measurements external to the skin and processes in the skin itself. A general description of skin structure is given and the mechanism of cell division is explained in detail to show its importance in determining the more radiosensitive parts of the skin. The difference between spontaneous and radiation induced skin cancer is described, and theories on radiation induced cancer, including the two-process theory, are discussed. (UK)

35871 (RLO-2049-2) EFFECTS OF IRRADIATION, TEMPERATURE, AND OTHER ENVIRONMENTAL FACTORS ON SALMONOID EMBRYOS. Progress Report. Welander, Arthur D. (Washington Univ., Seattle. Lab. of Radiation Ecology). June 9, 1969. Contract AT(45-1)-2049. 14p. Dep. CFSTI.

Fertilized eggs of chinook salmon were x-irradiated at various stages of development. Embryos were reared at temperatures of 8.5, 13, and 16°C. Tables are presented to show effects of radiation dose and temperature on mortality following irradiation of different stages of development. Eggs of the rainbow trout-steelhead trout hybrid (Salmo gairdneri) were incubated at temperatures of 15.5 and 17.2°C and subjected to x ray doses of 21, 81, and 203 R. Embryos irradiated and reared at elevated temperatures showed much greater mortalities than those irradiated and reared at ambient temperatures. The lowest mortalities occurred at the lowest temperatures. (H.L.W.)

35872 (UCRL-18884) STUDIES ON THE PROLIFERATIVE CAPACITY OF MACROPHAGE PROGENITOR CELLS IN THE MOUSE. Chen, Michael G. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1969. Contract W-7405-eng-48. 110p. Dep. CFSTI.

Thesis.

The proliferative capacities of progenitor cells of macrophages in inflammatory exudates were assessed, and the interrelations between different types of macrophage progenitor cells were elucidated. Radiation and the irreversible mitotic inhibitor, vinblastine sulfate, were employed to perturb steady state production of these progenitor cells and thereby allow analysis and identification of the different progenitor cell populations under study. Three functional types of progenitor cells were studied: macrophage precursors—rapidly proliferating cells of bone marrow origin, that label with tritium-labeled thymidine and are autoradiographically measurable as labeled mature macrophages in glycogen-induced

peritoneal exudates, agar colony-forming units (ACFU) committed to monocyte-macrophage differentiation — cells in hematopoietic tissue capable of forming in agar macroscopic colonies of phagocytic mononuclear cells indistinguishable from macrophages, and spleen colony-forming units (CFU) — cells in hematopoietic tissue capable upon transplantation of forming macroscopic nodules on the surface of the spleens of lethally irradiated recipient mice. The data showed that macrophage precursors and ACFU were γ-radiosensitive and mitotic inhibitor-sensitive cell populations, exhibiting sensitivities to these agents comparable to those reported for progenitor cells of other hematopoietic systems. The tempo and timing of recovery of these two types of progenitor cells after injury was similar to the pattern of recovery of erythropoietin-sensitive cells. The temporal patterns of recovery of ACFU and CFU after 200 R radiation were consistent with the view that ACFU are a population of cells distinct from CFU, but closely related to them. A model of the monocyte-macrophage system was proposed. The pluripotential CFU represent the most primitive, measurable progenitor cell population, that gives rise to ACFU as the earliest progenitor cells committed to monocyte-macrophage differentiation. In the steady state, macrophage precursors are largely made up of differentiated progeny of ACFU and daughter cells produced by self-renewal divisions within the ACFU compartment; CFU do not contribute significantly to the macrophage precursor population. ACFU fulfill many of the criteria of a dependent (committed) stem cell population as defined by McCulloch and co-workers. Analogies between this model and models proposed for other hematopoietic systems were discussed. (auth)

35873 THE COMBINED ACTION OF NEUTRAL DESOXYRIBONUCLEASE AND IONIZING RADIATIONS ON THE PROLIFERATIVE ACTIVITY OF THE CELLS OF EHRLICH'S ASCITES TUMOR. Magliulo, E.; Petrocini, S.; Fossati, G. C.; Gorini, S. (Univ., Pavia, Italy). Arch. Sci. Med., 125: 171-8(May 5, 1968). (In Italian).

Pancreatic DNAse and whole-body irradiation of mice bearing Ehrlich's ascites tumor (TAE) induced a sharp decrease in proliferative activity of tumor cells. Whereas the effect on the number of cells entering mitosis was one of simple summation, that on the course of mitosis, and particularly of metaphase was one of radiosensitization. Findings are discussed in relation to present views on dynamics of cellular proliferation and mechanism of DNAse and x-ray action. (auth)

35874 A COMPARISON OF EFFECTS OF NEUTRON AND ^{60}Co GAMMA IRRADIATION ON SHEEP. Wykoff, M. H. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Health Phys., 16: 804-6(June 1969).

Reference is made to a previous study of the effect of fission spectrum reactor fast neutrons on sheep, and it was decided to compare the effect of this type of irradiation at a rapid dose rate with the effects of low dose rate exposure to ^{60}Co gamma radiation. Irradiation was directed primarily to the head, and examination was made of blood and cerebrospinal fluid. Symptoms displayed by the animals, blood and cerebral spinal fluid findings, and survival times were very similar to those observed following fast neutron irradiation. Death occurred in both instances between the fifth and sixth days. The results were considered rather surprising, and raised questions concerning relative biological effectiveness. (UK)

35875 REGENERATION OF IRRADIATED LYMPH NODES IN TRANSPLANTATION IN VITRO AND IN VIVO. Didukh, M. S.; Luriya, E. A. (Inst. of Epidemiology and Microbiology, Moscow). Arkh. Anat., Gistol-Embriol., 52: No. 6, 33-9(June 1967). (In Russian).

Explants and isotransplants of the lymphatic nodes obtained from both normal and irradiated (2000r) mice of the lines A and $CBAT_6T_6$ were studied. Culturing of the lymphatic nodes in organ cultures (from normal non-irradiated animals) showed that the period of cell destruction, lasting the first several days, was followed by regeneration, resulting in almost complete restoration of the organ. Explantation of the lymphatic nodes in organ cultures from animals exposed to the dose of 2000r showed no regeneration of the lymphoid tissue, notwithstanding some proliferation of the cells of the stroma reticulo-endothelium. In such explants no lymphocytes were present. Isotransplantation of the lymphatic nodes from the irradiated mice-donors of the same lines brought about, in the majority of the transplants, restoration of the lymphoid tissue. On the basis of the data obtained and other results, it may be suggested that regeneration of the isotransplants was due to repopulated lymphocyte-like cells of the recipient and not to the cells of the reticulo-endothelium of the stroma. (auth)

35876 SUBMICROSCOPIC BASIS OF THYROID GLAND SECRETION. Voitkevich, A. A.; Zenzerov, V. S. Arkh. Anat., Gistol. Embriol., 55: No. 10, 21-9(1968). (In Russian).

A study was conducted of the state of the organoids participating in synthesis, secretion, storing, and excretion liberation of the thyroid hormones into the sanguiferous bed; special attention was given to metabolism of the colloid substance in the thyroid cells. Histological and electronmicroscopic investigations were carried out on the thyroid glands in 15-day old rats of the Wistar line. The thyroid gland of the young animals under study is characterized by sufficiently differentiated ultrastructural organization and by augmented level of the functional activity. The secretion process in normal animals was studied under activation with thyrotropic hypophyseal hormone (TTH) and under conditions of total γ-irradiation with the dose of 750 R. Within three hr after TTH administration, there was noted a mass appearance of the colloid drops in the cytoplasm of the functionally excited secretory cells. Simultaneously there was noted intensive elimination of such drops into the cavity of follicles, resembling the apocrine and, partially, merocrine secretions. In the apical zone of the cytoplasm there are concentrated numerous small granules and vesicles of various electron density. Such formations were partially localized inside the microvilli. The number and shape of the latter widely varied. During the first 24 hr after the total exposure there were observed some signs of excitation of the thyroid cells, increase in the cytoplasm volume and in the microvilli number, dilatation of cisterns of the ergastoplasm, appearance of the intracellular colloid, and swelling of the mitochondria. In such conditions the liberation of the colloid-like substance into the cavity of the follicles is accompanied with partial reduction of the cell cytoplasm. Portions of the ergastoplasm with mitochondria and ribosomes were eliminated together with colloid drops into the cavity of the follicles. (auth)

35877 THE THYMUS: A HEMATOPOIETIC ORGAN. 3. THE INFLUENCE OF THYMUS TISSUE IN DIFFUSION CHAMBERS ON THE SURVIVAL AND THE HEMATOPOIETIC SYSTEM OF MICE AFTER SUBLETHAL WHOLE BODY IRRADIATION. Schneiberg, K.; Jonecko, A.; Bartnikowa, Wieslawa (Institutes feur Onkologie, Gliwice, Poland). Folia Haematol. (Leipzig), 89: 265-82(1968). (In German).

Thymus-bearing diffusion chambers, when implanted intraperitoneally just after a whole-body irradiation of 500 X rays, were shown to restore normal radioresistence of thymectomized mice. The regeneration of lymphocytes in peripheral blood of these animals also was normalized. This promoting effect of thymus was shown to be endowed with specificity, inasmuch as other tissues (lymph nodes, spleen, and skeletal muscles) did not prove successful in modifying the acute radiation damage of these animals. Free intraperitoneal explants of thymus have shown some beneficial effect during a very short time. Humoral stimulation by the thymus of the animal's lymphopoiesis is postulated. Humoral thymic factors seem to enable extra-thymic lymphatic cells, by the same time, to undergo transformation into myeloid precursors, this quality being essential for an animal's survival from acute radiation damage. This humoral effect is only due to thymus whose structure as an organ was preserved. (auth)

35878 EFFECTS OF IRRADIATION ON PLASMA PROTEINS AND LEUKOCYTES IN THYMECTOMIZED AND CONTROL CHICKENS. Longenecker, Bryan M.; Breitenbach, Robert P. (Univ. of Missouri, Columbia). Proc. Soc. Exp. Biol. Med., 130: 418-21(Feb. 1969).

An attempt was made to elucidate a postneonatal function for the thymus in chickens. Twenty-six chickens were thymectomized at 2 weeks of age and 26 were sham-operated. At 8 weeks of age all birds were irradiated with 750 R cobalt-60 γ rays. Plasma protein and leukocyte values were measured in survivors. Three days after irradiation a 40 to 50% decrease in plasma protein occurred in control and thymectomized birds. This decrease was due to decreased amounts of albumin, and alpha-2, beta-2, and gamma globulin. By day 6 all of the globulins recovered to preirradiation levels, and in most cases there was an overcompensation noticeable by day 10. The albumin values, however, never returned to the magnitude of the starting values. No differences were observed between plasma protein responses of thymectomized and intact birds. Thymectomy caused a depression in the number of circulating small lymphocytes. The numbers of all lymphocyte types were markedly depressed by irradiation but they rebounded by day 6. Medium and small lymphocyte numbers did not recover as rapidly in thymectomized as in sham-operated birds. It is postulated that the postnatal avian thymus may contribute to the populations of small and medium lymphocytes. (auth)

35879 PLAQUE-FORMING SPLEEN CELLS FOLLOWING IRRADIATION OF X5563 TUMOR. Smith, Ealconer; Carlson, Patricia J.; Koenig, Sheila (American Univ., Washington, D. C.). Contract AT(30-1)-3861. Proc. Soc. Exp. Biol. Med., 130: 530-4(Feb. 1969).

Exposure of the transplanted plasma-cell tumor X5563 in C_3H/eB mice to 6.75 krads of ^{137}Cs gamma radiation resulted in complete regression in about 85% of the treated tumors. Primary immunization of experimental mice with sheep erythrocytes done 13 to 28 days after tumor irradiation was associated with spleen plaque-forming cell (PFC) counts and hemolysin titers on the fifth day following that were within the range observed for nontumorous controls. Mice whose tumors were irradiated within 3 hr before immunization had nearly four times more PFC on the average. The way in which the X5563 tumor produces suppression of IgM synthesis is not clear although its prompt recovery following tumor irradiation suggests that the tumor's suppressive action is closely linked with the active metabolic state of the growing neoplasm. (auth)

35880 STUDIES ON THE INFLUENCE OF X IRRADIATION UPON TEETHING IN GOLDEN HAMSTERS. Piekos, Boleslaw (Zaklad Biologii i Embriologii, Krakow). Czas. Stomatol., 20: 1269-74(1967). (In Polish).

Studies were conducted in 55 female gold hamsters (wt 120 to 150 g), aged 5 to 10 months, with 42 female hamsters as controls. Prior to irradiation, pregnant hamsters were divided into 7 groups according to stage of pregnancy, i.e. by 8, 10, 11, 12, 13, 14, and 15 days. All groups of hamsters received a single dose of 70 R of whole-body x irradiation. The objective was the assessment of the radiation effects on the offspring of irradiated mothers, particularly on the dentition of incisors and molar teeth in the young. It was found that while the appearance of cutting teeth was on time, subsequent growth of some teeth through the gum was delayed by 1 to 4 days. Statistically, the highest percentage of retarded teething involved the 3rd molars in group 6 (19%) and in group 7 (20%). No dentition delays of 3rd molars were observed in groups 1 through 5. The least delayed (4.2%) were the incisors in group 6. The ascending rate of delayed incisors appeared in group 5 (4.7%), group 2 (5.6%), group 4 (5.8%), and group 3 (7.7%). In the author's opinion, ionizing radiation affected the mesenchymal elements of the pulp and retarded tooth development to some degree. (BBB)

35881 THE USE OF THE SUPRAVITAL METHOD IN A STUDY OF CELLS SUSCEPTIBLE TO DAMAGE IN SMEARS OF NORMAL AND REGENERATING BONE MARROW. Rosse, C. (Univ. of Washington, Seattle). Blood, 34: 72-84(July 1969).

Cells susceptible to damage during smearing were identified in the different cellular compartments of normal and regenerating bone marrow of the guinea pig by comparing differential counts on fixed dry smears and on supravitally stained wet preparations. In smears of normal marrow, the majority of damaged cells were myeloid cells, although the most fragile cell appeared to be the monocyte. In normal marrow, erythroblasts and lymphoid cells did not damage in significant numbers. During recovery from sublethal γ irradiation the number of damaged cells increased significantly in each cell compartment at the time when that compartment commenced its regeneration. In contrast to normal marrow, at the time of lymphoid regeneration 60% of transitional cells had damaged and at the start of erythroid and myeloid regeneration 40 to 50% of erythroid and myeloid cells were concealed on smears by damage. Labeling with ^3H-thymidine indicated that in smears of normal as well as of regenerating marrow, a large proportion of cells susceptible to damage in the various cell compartments was capable of proliferation. (auth)

35882 EFFECTS OF X-IRRADIATION ON PARAMETERS OF TUMOR GROWTH, HISTOLOGY, AND ULTRASTRUCTURE. Fisher, Edwin R.; Fisher, Bernard (Univ. of Pittsburgh, Veterans Administration Hospital, Pittsburgh). Cancer, 24: 39-55(July 1969).

X irradiation of transplants of Walker and mammary carcinomas in legs of Sprague-Dawley and syngeneic C3H mice respectively resulted in inhibition of growth of these primary tumors. Yet, the incidence and extent of pulmonary metastases from irradiated Walker carcinoma were comparable to controls. Metastases in lymph nodes were decreased only after irradiation with 5000 rads. No pulmonary metastases were encountered in controls with transplants of mammary carcinoma, whereas approximately one third of those subjected to 2000 rads exhibited such lesions. Cells of both tumors exhibited histopathologic and ultrastructural aberrations at various times following irradiation that were distinct from the direct effect of this modality on cell structure. Cells of pulmonary metastases resembled those of untreated tumors. This information, as well as other considerations, suggest that these apparently reversible cellular mutations might be concerned with the metastases from these tumors. X irradiation of lungs and liver prior to intrajugular and intraportal inoculation of Walker tumor cells resulted in enhancement of metastases in these organs. This tumor bed effect appeared to be organ specific and was not related to trapping of tumor cells at these sites. On the other hand, prior irradiation of the limb inhibited growth of subsequent implants and, in some instances, regression was noted. Pulmonary and nodal metastases in this situation appeared related to the size of the primary growth. Although no analogies between these findings and clinical experiences are intended, nevertheless they emphasize the need for studies that might allow for proper evaluation of the efficacy of pre- and postoperative irradiation in the therapy of human neoplasms. (auth)

35883 PERIODICITY DURING RECOVERY OF ERYTHROPOIESIS FOLLOWING IRRADIATION. Morley, Alec; Stohlman, Frederick Jr. (St. Elizabeth's Hospital, Boston, Tufts Univ. School of Medicine, Boston). Blood, 34: 96-9(July 1969).

Twelve to sixteen week old female CFI_s mice were irradiated with 200 rad of whole-body x irradiation (dose rate 48 rad/min., 250 kV, 15 mA, 1.0 mm. Cu and 1.0 mm. Al filtration). Every 2 or 3 days thereafter 5 treated mice and 1 control were sacrificed and red cell, reticulocyte, and total and differential white cell counts were performed using standard methods. Serial changes in red cell count and in absolute reticulocyte and neutrophil counts were observed. The neutrophil count showed an early rise followed by a fall; subsequently there may be a suggestion of oscillation but this is not definite. However, the reticulocyte count clearly and the red cell count probably showed damped oscillation. During the first 6 to 8 days of the study the decrease in reticulocyte count was undoubtedly due to the decrease in stem cell number following irradiation. However, for the remainder of the experiment fluctuations in reticulocyte number followed about 5 days after fluctuations in red cell count. Conversely the fluctuations in red cell count appeared to follow changes in reticulocyte production. These findings suggest that the cause of oscillation was a single closed feedback loop containing a total time-delay of about 5 days. Since the production of erythropoietin is rapid, nearly all of this delay of 5 days can be attributed to the time taken for the erythropoietin-responsive stem cell to mature and become the blood reticulocyte. (E.R.B.)

35884 BACTERICIDAL ACTIVITY OF FIXED PHAGOCYTES IN IRRADIATED AND UNIRRADIATED MICE TREATED WITH ENDOTOXIN. Johnson, Henryka B.; Hammond, Carolyn W. (Univ. of Illinois, Chicago). Proc. Soc. Exp. Biol. Med., 130: 504-8(Feb. 1969).

Mice were injected intravenously or intraperitoneally with 3 or 12 μg of S. typhosa endotoxin, respectively. One group received 550 R of x irradiation 24 hr later. Five days after endotoxin administration all mice were injected intravenously with Ps. aeruginosa. One min after receiving the pseudomonad injection the mice were given 5 mg of Colistin intravenously to kill extracellular bacteria. Livers and spleens were removed from the infected mice 24 hr later, ground, and the number of viable bacteria per organ was determined by culture methods. Heart's blood was cultured for extracellular bacteria. The results indicated that greater numbers of bacteria were killed within the livers and spleens of endotoxin-treated animals than controls. Only the livers of endotoxin-treated x-irradiated animals showed higher bactericidal ability. (auth)

35885 CHANGES IN THE MITOTIC ACTIVITY OF THE EPITHELIUM OF THE SMALL INTESTINE OF PIGLETS AFTER WHOLE-BODY IRRADIATION WITH X-RAYS. Otoupal, P.; Matouch, O.; Kunstyr, I. (Military Veterinary Research Inst., Prague). Vet. Med. (Prague), 14: 191-7(Mar. 1969). (In Czech).

Mitotic activity in undifferentiated crypt cells was examined in sections from the small intestine of whole-body irradiated pigs. Thirty-five two-month-old pigs of both sexes were divided into seven groups, six of which were irradiated with 600 R doses. The animals were killed 12 hours, or 1, 3, 5, 8, or 14 days postexposure. Marked increases in mitotic activity were particularly evident in the 12-hr jejunum and the 24-hr duodenum and ileum. Peaks were observed in all sections on the 3rd and 5th days postexposure. From 8 to 14 days postexposure, mitotic activity decreased to values approaching that in the control group. (auth)

35886 GRAFT VERSUS HOST REACTION MODIFIED BY IN VITRO MARROW-ERYTHROCYTE PREINCUBATION. Uphoff, D. E. (National Cancer Inst., Bethesda, Md.). Nature (London), 222: 1089-90(June 14, 1969).

Specific skin allograft tolerance was induced in 94% of lethally irradiated AKR mice recipients by transplantation of AKR marrow preincubated in vitro with allogeneic erythrocytes, and it was suggested that tolerance resulted from failure of preincubated marrow to recognize the erythrocyte-donor strain as foreign. The functional capacity of the marrow stem cells was altered, but this did not affect the protective capacity of the marrow. A study was made

to determine whether this preincubation method would alter the lethal effects of the graft versus host reaction. Data are given for comparative survival of lethally irradiated (CBA X AKR)F recipients inoculated with normal AKR marrow and AKR marrow preincubated with allogeneic erythrocytes. Unaltered 14 day survival values indicated that the incubation procedure did not change the protective capacity of the marrow. The best long term survival and the greatest delay in onset of the graft versus host reaction occurred after preincubation of AKR marrow with hybrid erythrocytes. There was no difference in survival when erythrocytes of reciprocal hybrids were used. Preincubation of AKR marrow with CBA erythrocytes resulted in an intermediate effect. In vitro modification of responsiveness of marrow stem cells before transplantation has the advantage over other methods for preventing the graft versus host reaction of avoiding the toxic side effects of immunosuppressive drugs. (UK)

35887 EFFECT OF WHOLE-BODY X-IRRADIATION ON THE MEDIAN LIFESPAN OF FEMALE DOGS (BEAGLES). Andersen, A. C.; Rosenblatt, Leon S. (Univ. of California, Davis). Contract AT(04-3)-472. Radiat. Res., 39: 177-200(July 1969). (UCD-472-224).

Median survival time (MST) and major causes of death were determined for 360 control and x-irradiated female beagles. At 10 to 12 months of age the beagles were given single or fractionated x-ray (250-kVp) exposures totaling either 100 R or 300 R. Thereafter they were maintained in outdoor pens for lifetime studies. Most deaths occurring during the first 3 yr postirradiation appeared to be due to synergism between the effects of environmental stresses and x irradiation. In the final analyses, all irradiated beagles exhibited life-span shortening relative to controls: 9.5% and 20.7% for the 100-R and 300-R groups, respectively. On a linear scale this represented a loss of 6.7% per 100 R. Differences between subgroups receiving fractionated exposures were apparent only at 300 R, where life-span shortening was reduced when the elapsed time between first and last exposure was increased from 7 to 84 days. Mortality rates could be fit to the Gompertz equation only during the last 6 yr of life. The Gompertzian slopes were similar for all groups, except that irradiated groups attained higher mortality rates earlier in life than controls. Neoplasms and chronic diseases were the major causes of death, and these entities were similar in controls and irradiated beagles. Results from this study agree quite well with those obtained from rodents. (auth)

35888 EFFECTS ON SWINE OF UNILATERAL NEUTRON IRRADIATION, CALCIUM, AND ZINC. Rosas, H.; Bell, M. C. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-Gen-242. Radiat. Res., 39: 164-76(July 1969).

Twenty-four weanling barrows were selected according to body weight and assigned to three dietary treatments: basal (0.6% Ca and 29 ppm Zn); basal + 0.6% Ca; and basal + 0.6% Ca + 71 ppm Zn. Unilateral neutron irradiation (268 RADS) was administered to half of each treatment group. Twenty-four hr postirradiation, all swine were orally dosed with 0.5 mCi of ^{65}Zn. Whole-blood and plasma levels of ^{65}Zn were significantly lower in the irradiated animals for several days. In vitro uptake of ^{65}Zn by erythrocytes from the swine fed supplemental zinc was lower, but no differences were found in stable zinc in erythrocytes. Ad libitum feed intake was the same for all treatments, but average daily gain was lower in the irradiated swine. Radiation significantly decreased left kidney, liver, and spleen weights, heart weight, and hair growth. An absence of pigment was observed in the hair cortex on the side of the animal exposed to the reactor. Claudication of the left rear leg, facing the reactor, was observed in all swine. A significant lower value for weight and length in legs near the reactor was observed. (auth)

35889 ERYTHROPOIETIC RESPONSE IN DOGS GIVEN SUBLETHAL WHOLE-BODY PROTON IRRADIATION FOLLOWED BY HYPOXIC HYPOXIA. Aceto, Henry Jr.; Springsteen, Robert; Gee, W.; Winchell, H. S.; Tobias, C. A. (Univ. of California, Berkeley). Radiat. Res., 39: 101-11(July 1969).

Serial iron kinetics studies and ^{32}P tracer determinations of total red cell volume were performed in three groups of beagles exposed to hypoxia (pO_2 = 72 mm Hg), sublethal whole-body proton irradiation (200 RADS midline absorbed dose in tissue), or a combination of these two stresses. Hypoxia alone resulted in an increase, within 1 day, in plasma iron turnover rate (PITR), an increase in fractional incorporation of ^{59}Fe in red cells, and a corresponding elevation in total red cell volume. Sublethal whole-body proton irradiation alone resulted in diminution in PITR within 1 day, and a corresponding marked depression of fractional incorporation of ^{59}Fe in red cells. Dogs receiving a combination of whole-body proton irradiation followed by hypoxic hypoxia demonstrated an initial increase in plasma iron turnover rate (PITR) for the first 7 days approximating the response seen with hypoxia alone. At 14 days the PITR and the fractional ^{59}Fe incorporation into red cells rapidly decreased, approaching, but not reaching, that seen in the dogs receiving radiation alone. Thereafter, the increase in the PITR in these dogs was greater than that seen following irradiation alone and by 29 days again approximated that seen in dogs subjected to hypoxia alone. At all times total red cell volume in dogs subjected to combined whole-body irradiation and hypoxia was maintained at a level intermediate between that seen in dogs subjected to whole-body irradiation alone or to hypoxia alone. It was concluded that, following sublethal whole-body proton irradiation, cells responsible for synthesis of hemoglobin were capable of normal or increased rates of hemoglobin synthesis in response to hypoxic stimulation despite severe radiation damage. Red cells produced under such hypoxic stress following whole-body irradiation were not extremely short lived and were functionally significant as evidenced by normally shaped red cell ^{59}Fe incorporation curves and red cell volumes that were greater than that noted in dogs receiving radiation alone. Those cells present in the bone marrow at the time of irradiation that were responsible for hemoglobin synthesis during the ensuing 7 days were little affected by 200 RADS of whole-body proton irradiation, with regard to their capability of synthesizing hemoglobin in response to hypoxia. Additionally, although those cells present in the bone marrow at the time of irradiation that were responsible for hemoglobin synthesis beyond 7 days following irradiation were more affected by 200 RADS of whole-body proton irradiation than were those cells responsible for hemoglobin synthesis during the initial 7 days, even these cells were capable of being stimulated by hypoxic hypoxia. (auth)

35890 DESTRUCTIVE EFFECTS OF STRICTLY LOCAL IRRADIATION OF THE EYE OF THE ADULT AXOLOTL (SIREDON MEXICANUM). Brunst, V. V. (Roswell Park Memorial Inst., Buffalo). Radiat. Res., 39: 26-35(July 1969).

In the present study, axolotls were irradiated with 30,000 R limited to the right eye. Damage to the lens was different from such damage after irradiation with smaller doses. Immigration of macrophages was not observed. The lens fibers and nuclei disappeared, leaving inside the lens only a fibrous structure with many vacuoles. The fibers were transformed into a much softer material, perhaps even a liquid. The eye was completely destroyed whenever the orbital region was in the center of the field of irradiation. In all such cases, the cornea and lens were completely absent. Sometimes very small accumulations of retinal cells with mitotic figures were found. The tissues of the choroid coat and the sclera were the least radiosensitive, particularly the pigment layer and the ocular cartilage, but even they were left completely disorganized. The effects of the same dose of radiation administered with different degrees of localization can thus differ not only quantitatively, but also qualitatively. Such qualitative differences are chiefly due to the relation of the time of fixation to the latent period. After 30,000 R, the latent period for damage to the axolotl lens is about 24 days. (auth)

35891 RESPONSES OF BROILER CHICKS TO GAMMA-RADIATION EXPOSURES: CHANGES IN EARLY GROWTH PARAMETERS. Brisbin, I. Lehr Jr. (Savannah River Ecology Lab., Aiken, S. C.). Contract AT(38-1)-310. Radiat. Res., 39: 36-44(July 1969).

Ninety broiler chicks were exposed at the age of 2 days to single doses of γ radiation, delivered at the rate of 8 R/min. Total exposures ranged from 100 to 900 R. No mortality that could be attributed to radiation exposure was observed in any of the birds during the first 30 days after exposure. Although growth rate decreased significantly with increasing dose, the decrease was nonlinear. Growth rate was little affected by additional dose between the levels of 300 R and 600 R. The highest level that the birds could tolerate without any significant decrease in early growth rate was 200 R. Thirty-two-day weights decreased linearly with increasing dose, the decrease averaging 19 g per 100 R of additional exposure. However, a series of allometric growth measurements revealed no significant change in the length of the culmen, tarsus, or longest primary wing feather with increasing dose. Only the middle toe was significantly smaller at the higher dose levels. It appears that body size is less affected by radiation exposure than body weight. (auth)

35892 IN-VIVO STUDIES OF 16- AND 24-W ^{238}Pu CAPSULES. Huffman, F. N. (Thermo Electron Corp., Waltham, Mass.); Spira, J.; Pegg, C. A. S.; Sandberg, G.; Lee, R.; Norman, J. C. Trans. Amer. Nucl. Soc., 12: 48-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

35893 A RADIOBIOLOGICAL STUDY OF IMPLANTED NUCLEAR POWER SOURCES FOR ARTIFICIAL HEARTS. Comar,

C. L.; Kalifelz, F. A.; Casarett, A. P.; Craig, P. H. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 12: 49(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

34894 RADIOSENSITIZATION OF BONE MARROW STEM CELLS BY MITOMYCINE C. Fuhrer, J.; Hery, C.; Duplan, J.-F. (Fondation Curie, Paris). Bull. Cancer, 55: 129-36 (Jan.-Mar. 1968). (In French).

Following treatment with 50 γ of Mitomycin C (MC) the haematopoietic stem cells of the mouse became sensitized to the lethal effect of x radiation. The slope of the dose-survival curve becomes steeper, indicating that the radiation efficiency was increased by a factor of 1.7. M.C. does not counteract the spontaneous process of early cell repair that reduces partly the cellular damages induced by x rays. Finally it appears that the small fraction of cells that survives the combined effects of M.C. and x radiation, is more radioresistant than the normal population of stem cells. (auth)

35895 RADIATION BREEDING OF THE DOMESTIC FOWLS. 3. THE EFFECT OF RECURRENT IRRADIATION OF GAMMA RAYS (^{60}Co) EACH GENERATION ON THE REPRODUCTIVE FUNCTION. Kashiwabara, Takao; Tanaka, Ryoichi (Ibaraki Univ., Japan). Ibaraki Daigaku Nogakubu Gakujutsu Hokoku, No. 16, 51-7(Oct. 1968). (In Japanese).

The experiments reported here were designed to study the effects of recurrent γ irradiation every and every other generation on chick growth, egg production, and reproductive ability. About four-month old chicks (F_2) were kept for 62 days in cage batteries with total doses of 500 R (dose rate 8.0 R/day) and 1,000 R (dose rate 16.1 R/day) at the γ field. The results were as follows: In cockerels irradiated with γ rays of 500 R, the growth rate of White Leghorn (WL) and New Hampshire (NH) were less than that of control, and the growth of pullets irradiated with 1,000 R was the same as cockerels in both breeds, but WL pullets irradiated with 500 R showed the same growth as that of control. In general, the growth of irradiated groups was almost the same as that of control. The sexual maturity was delayed about 40 days in every irradiated group, and egg laying of four pullets among eight NH pullets irradiated with 1,000 R was not observed by 270 days of age. The laying intensity was the same as that of control. In the breeding experiments, the fertility of irradiated groups was not declined, but their hatchability was lower than that of control, and the rate of raising of both breeds irradiated with 1,000 R was declined, but the WL irradiated with 500 R have maintained the control level. The results of growth, egg production, and reproductive ability were observed in relation to exposed histories of ancester of the chicks (F_2). In consequence, a tendency to the delay of sexual maturity and the decline of hatchability on both breeds with recurrent irradiation of γ rays each generation was distinguished. The doses useful in the radiation breeding of the domestic fowls by the recurrent irradiation each generation were concluded to be 500 R maximum for male and female stocks with a dose rate of 10/R day. (NSA of Japan)

35896 RADIATION BREEDING OF THE DOMESTIC FOWLS. 4. THE IRRADIATION OF HATCHING EGGS. Kashiwabara, Takao; Matsumoto, Takuya (Ibaraki Univ., Japan). Ibaraki Daigaku Nogakubu Gakujutsu Hokoku, No. 16, 59-64(Oct. 1968). (In Japanese).

The effects of x-ray dosage on hatchability of fresh laid fertile eggs were studied using high voltage source of Liniac and Maxitron. 1,236 hatching eggs were exposed prior to incubation to x rays with total doses of 50 to 2,000 R and a dose rate 300 R/m. (Liniac) and 50 R/m. (Maxitron). No eggs receiving more than 2,000 R hatched. In the group receiving between 1,000 R and 1,500 R hatching amounted to 2.7% of that of the controls. Following an exposure to 700 to 900 R, the hatching rate was about 13.9 to 3.1% and under 500 R it was about the same as that of the controls. Egg production of the irradiated groups was about the same as that of the controls. (NSA of Japan)

35897 COMPARATIVE STUDIES OF LYMPHOCYTOPENIC MEASURES. Pichlmaier, H.; Junginger, Th. (Univ., Munich). Z. Gesam. Exp. Med., 143: 293-9(1967). (In German).

It was shown that extracorporeal irradiation, drainage of lymph, and injection of antilymphocyte serum cause lymphopenia and prolong the time required for rejection of skin grafts. Antilymphocyte serum was more effective in this respect than the other methods. In rat blood two groups of lymphocytes could be distinguished morphologically that possibly have different immunological activities and are differently affected by the lymphocytopenic methods referred to. One type of cell has a clear cytoplasm and the other a basophilic one. These methods produce a rebound lymphocytosis, whereas lymphocytosis could never be achieved by the infusion of isologous lymphocytes. Rebound lymphocytosis is also due to a humoral factor that after passive transference produces a marked increase in lymphopoiesis. Extracorporeal irradiation for 20 min in 183 Sprague–Dawley rats caused a drop in the clear-cytoplasm type of lymphocyte to 30% the initial value. Six days later, normal levels had returned. The basophilic-type cells were unaffected by irradiation. (BBB)

35898 EFFECT OF X-IRRADIATION ON RETICULOENDOTHELIAL PHAGOCYTIC FUNCTION AND SERUM OPSONIC ACTIVITY. Saba, Thomas M.; Di Luzio, N. R. (Univ. of Tennessee, Memphis). Amer. J. Physiol., 216: 910-14(Apr. 1969).

Total-body x irradiation with 800 R markedly impaired the phagocytosis of a gelatinized ^{131}I-labeled triolein RE-test-lipid emulsion in adult rats. Tissue distribution and clearance rate determinations of the emulsion demonstrated a progressive impairment in phagocytosis associated with corresponding decreases in hepatic and splenic macrophage activity. Opsonization of the emulsion with normal serum prior to intravenous injection augmented its intravascular clearance in x-irradiated rats. The enhanced clearance of the opsonized particles in irradiated rats was associated with an enhanced bone marrow uptake whereas liver and spleen uptake remained unaltered. Analysis of serum opsonic activity revealed a slight, but significant elevation at 48 hr postirradiation. Radiation exposure prior to particle induced RE blockade did not impair the subsequent restoration of circulating opsonins. The data indicate that lethal whole-body x irradiation selectively depresses hepatic and splenic phagocytosis. (auth)

35899 HISTOLOGIC EFFECTS OF ENDOLYMPHATIC RADIOTHERAPY. Lord, Reginald S. A.; Kinmonth, J. B. (St. Thomas Hospital, London). Cancer, 23: 440-50(Feb. 1969).

Lipid preparations labeled with ^{32}P and ^{131}I were infused directly into lymphatic vessels draining to V_x2 tumor-involved lymph nodes in the rabbit. The animals were killed from 1 to 250 days later, at which time the target lymph nodes and other viscera were examined. The initial response of the infused lymph nodes was characterized by a rapid necrosis of all cells within the physical range of the isotope. Cellular debris was then removed leaving little more than the original fibrous framework of the node. Progressive fibrosis followed, eventually forming a contracted sclerotic mass, unrecognizable as a normal node. The lungs, liver, spleen, bone marrow, kidneys, ureters, and bladder were also examined. No specific effects of radiation were detected in these organs. The technique proved safe for other organs while achieving massive oncolysis in the target lymph nodes. (auth)

35900 EFFECTS OF IRRADIATION, AGE, SEASON, AND COLOR ON MINERAL COMPOSITION OF HEREFORD CATTLE HAIR. O'Mary, C. C. (Washington State Univ., Pullman); Butts, W. T. Jr.; Reynolds, R. A.; Bell, M. C. J. Anim. Sci., 28: 268-71(Feb. 1969).

Whether the mineral composition of hair is altered in Hereford cattle surviving whole-body ^{60}Co γ radiation was studied, as well as the effect of age, season, and color on the percent ash or the concentration of nine selected minerals in Hereford cattle hair. The seven cows had survived doses ranging from 400 to 1600 R, given between 1959 and 1965 (not over 400 R at any one time). No significant differences in the mineral composition of the hair from irradiated and nonirradiated Hereford cattle were found. Coat color as noted visually was not affected by irradiation. Highly significant differences appeared between seasons in seven of the nine elements studied. In August the hair contained greater amounts of Na, Cu, Ca, Mg, Mn, and K when compared to samples taken in March. In March a higher content of Fe was noted. Red hair contained a greater percent of ash, and more Ca, P, Mg, Mn, Fe, and K but less Cu than white hair. There was more Cu in white hair than red hair in August but little difference in March. The hair from calves contained more Na, Ca, Cu, and K, but less Mn and Fe than that from cows. Interactions of time x color were found for Cu, Mn, and Fe. Time x group interactions were found in percent ash, Ca, and Fe. Color x group interactions were also noted in percent ash, Na, Cu, Ca, Mn, Fe, and K. (BBB)

35901 THE SIGNIFICANCE OF INTRAMEDULLARY CANCELLOUS BONE FORMATION IN THE REPAIR OF BONE MARROW TISSUE. Amsel, S.; Maniatis, A.; Tavassoli, M.; Crosby, W. H. (New England Medical Center Hospitals, Boston). Contract AT(30-1)-3808. Anat. Rec., 164: 101-12(May 1969).

The effect of radiation on the regeneration of bone marrow cells following mechanical disruption of marrow was studied in Wistar rats. Disruption was performed at 2, 21, 60, and 120 days following a 4000-R x-ray dose and at 2 and 21 days following a 1000-R dose. After disruption, animals were examined at 3, 6, 9, 12, and 45 days. In nonirradiated disrupted marrow, a stereotyped train

of histologic events occurred: capillary invasion of the cavity, appearance of primitive mesenchymal cells, osteoblastic proliferation, cancellous bone formation, development of sinusoids, reappearance of hemopoietic tissue, and resorption of cancellous bone. Restoration of marrow sinusoids took place only in the interstices of cancellous bone. Irradiation of the tibia with 1000 R followed by disruption of the marrow 2 or 21 days following irradiation led to formation of cancellous bone. The stereotyped sequence of histologic events described above occurred in the reparative process. By day 45, the marrow had sinusoidal architecture, with minimal hypocellularity and the cancellous bone had disappeared. Following disruption of the bone marrow 2, 21, 60, or 120 days after irradiation by 4000 R, there was no cancellous bone formation. Control animals receiving 1000 or 4000 R to the tibia developed no cancellous bone at any time. The cell which can differentiate into an osteoblast is evidently resistant to 1000 R. (BBB)

35902 DISRUPTION OF RADIATION-INDUCED AVERSION TO SACCHARIN BY ELECTROCONVULSIVE SHOCK. Riege, Walter H. (Univ. of California, Berkeley). Physiol. Behav., 4: 157-61(Mar. 1969).

The separate and interactive effects of x irradiation and electroconvulsive shock (ECS) upon trained saccharin preference were examined under a 2 × 2 factorial design. On the day of irradiation all animals had access to only 0.1% saccharin solution. While they were drinking, the rats were exposed to 82 R of x rays. Then they received ECS or sham ECS. Irradiation did not result in a complete aversion but in a 25% decrement in mean saccharin preference. Rats shifted their previously stable preferences for a 0.1% saccharin solution to an inclusion of water in their fluid intake after low-dose x irradiation, but failed to do so when given a single ECS in some temporal proximity to the exposure period. The retrograde amnesia exerted by the shock treatment was even effective in trace and in backward conditioning situations. A conditioned aversion failed to develop during more than 5 days after irradiation in rats simultaneously given ECS. The learning character of the radiation-induced aversion is discussed. (BBB)

35903 EARLY AND LATE REACTIONS IN SKIN OF RATS FOLLOWING IRRADIATION WITH X RAYS OR FAST NEUTRONS. Field, S. B. (Hammersmith Hospital, London). Radiology, 92: 381-4(Feb. 1969).

The normal tissues of the feet of rodents were irradiated with single or fractionated doses of x rays or fast neutrons. The relations between the various stages of visible damage after each treatment were investigated, and it was found that the relations between the early reactions (seven to thirty days after irradiation), late reaction (five to twenty-three weeks), and permanent deformity were independent of the treatment and for all treatments, the early reaction increased steadily with increasing dose, whereas the corresponding late reactions were quite small until a certain level of early reaction was reached, following which they increased in severity very rapidly. (auth)

35904 CHANGES OF HEMOSTASIS IN THE ACUTE IRRADIATION SYNDROME. Poppa, C.; Enache, Florica (Centrul de Hematologie, Bucharest). Docum. Haematol. (Bucharest), 1: 75-87(1967). (In Rumanian).

The effect of 180-kV x radiation on blood coagulation in the dog was investigated. A brief review of the mechanism by which radiation induces changes in hemostasis is also presented. Results obtained in 2 lots of 25 dogs, each of which were x irradiated (75 to 300 R), are described. After a description of the material and the methods used in the study, the results are analyzed and it is shown that the effect of small doses of radiation is different from that of larger doses. In either case the effect is carried out through the megakaryothrombocytic system. The clotting parameters determined in dogs receiving 75, 150, 225, and 300 R included thrombocyte counts, thromboelastogram values, capillary resistance, Quick time, prothrombin time, heparinemia, fibrinogenemia, fibrinolytic activity, and hematocrit. (BBB)

35905 CONTRIBUTION TO THE INVESTIGATION OF FACTORS ACTING ON HEMATOPOIETIC STEM CELLS IN THE SPLEENS OF IRRADIATED MICE. Tkadlecek, L.; Fabova, M.; Juraskova, M. (Purkyne Military Research and Postgraduate Training Inst., Hradec Kralove, Czech.). Cas. Lek. Cesk., 108: 392-7(Mar. 28, 1969). (In Czech).

Serial histological sections of colonies of hematopoietic tissue developed from stem cells injected one and four days after irradiation were compared. The colonies originating from cells injected after four days developed faster than those injected after one day. Development of these colonies was interrupted by repeated transfusions of erythrocytes. Polycythemia resulted in: arrested development of the majority of erythropoietic colonies; dedifferentiation of some of the cells; and their transformation into precursors of myeloid cells. (JPRS)

35906 HEMORRHAGE SYNDROME IN RADIATION SICKNESS. I. EXPERIMENTAL STUDY OF THE CHANGES IN COAGULATION AND FIBRINOLYSIS IN RATS EXPOSED TO LETHAL X-RAY DOSES. Cutcudache, Caliopi; Voronca, Gabriela; Gorun, Vera; Brailescu, G.; Popa, Rodica; Popescu, G. Fiziol. Norm. Patol. (Bucharest), 14: 351-62(July-Aug. 1968). (In Rumanian).

Blood fibrinolysis and clotting alterations were followed in rats irradiated with a total dose of 700 R, 2, 5, 10, and 15 days after irradiation, and in a group of normal controls. The results showed a tendency to hypocoagulability due to severe thrombocytopenia, the deficient utilization of prothrombin, increase in the heparin co-factor and antithrombin III, decrease in proaccelerin, and a tendency to an increase in the activity of the fibrinolytic activators. The possible pathogeny of these changes and the interpretations of other authors are discussed. These biologic alterations are accompanied by a hemorrhagic syndrome. (auth)

35907 ORIGIN OF REPOPULATING CELLS AFTER LOCALIZED BONE MARROW DEPLETION. Maloney, Mary A.; Patt, Harvey M. (Univ. of California, San Francisco). Science, 165: 71-3(July 4, 1969).

The restoration of marrow in a mechanically depleted segment of rabbit femur is locally determined and apparently initiated by cells normally resident in bone. This conclusion follows from results of two types of radiation experiments: local x irradiation of the femur shaft immediately before depopulation and x irradiation of the total body with exception of the femur diaphysis that was depopulated either just before or after irradiation. In contrast to the rapid initiation of marrow restoration in an unirradiated femur, there was little regeneration during the first 3 weeks in an irradiated femur. Recovery of the shielded depopulated femur in the rabbit that otherwise received total-body irradiation was similar to that in the unirradiated animal. Hence, it would appear that the seeding of circulating hemic stem cells is not essential to repopulation and that cells with hematopoietic potential are present in osseous tissue. (auth)

35908 CELL POPULATION KINETICS IN RADIATION-INDUCED HYPERPLASTIC EPIDERMIS OF GUINEA-PIG SKIN. Song, Chang Won; Tabachnick, Joseph (Albert Einstein Medical Center, Philadelphia). Int. J. Radiat. Biol., 15: 171-4 (1969).

The kinetics of cell population turnover in the hyperplastic epidermis of β-irradiated guinea pig skin was compared with contralateral unirradiated tissue in an effort to elucidate the mechanisms responsible for this abnormal growth. Four 1-inch square sites on the shaven right flank of albino male guinea pigs were irradiated at 3,000 rep of B rays from a $^{90}Sr-^{90}Y$ sealed source (dose rate of 750 rep/min). Fifty and 150 days later tritium-labeled thymidine was injected intradermally into irradiated and unirradiated skin areas; the pigs were killed 1 hr later. Autoradiograms of guinea pig epidermis revealed that in the normal epidermis, labeled cells were restricted in the lower-most single cell layer; in the regenerated epidermis, labeled cells (^{3}H-thymidine) were located in 2 to 3 layers of basal cells. There was no significant difference in duration of DNA synthesis between control and irradiated cells. The turnover times of regenerated epidermis 50 and 150 days after irradiation were remarkably similar; 14.0 and 13.8, respectively. It was suggested that in the regenerated acanthotic epidermis a feed-back control mechanism suppressed the proliferative activity to compensate for the overgrown cell population and, as a result, a new steady state of cell turnover at a new population level was established. (C.O.)

35909 DOSE-MORTALITY STUDIES FOR MICE IRRADIATED WITH X-RAYS, GAMMA-RAYS, AND 15 MeV NEUTRONS. Broerse, J. J. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol., 15: 115-24(1969).

Acute mortality in mice, occurring within 5 or within 30 days after the end of the exposure, was studied after irradiation with x rays, gamma rays, or 15 MeV neutrons in either 2-hr or 8-hr exposures. Death due to the haematopoietic syndrome occurred mainly between 8 and 14 days after exposure, whereas a mean survival time of 4.5 days was found for the intestinal syndrome. For 15 MeV neutron irradiations and 2-hr exposure time, the LD_{50}-values for the two syndromes differed by nearly 300 rads. Mortality due to the intestinal syndrome was not observed in the range of the lowest lethal doses. RBE values of 1.1 and 1.4 with respect to 250 kVp x rays were obtained for haematopoietic death and intestinal death, respectively. The effect of protraction of the exposures to gamma rays and neutrons suggests that there are intrinsic differences between the cellular radiosensitivity of intestinal cells and bone-marrow cells. (auth)

35910 RESORPTION OF ^{137}Cs THROUGH MECHANICALLY DAMAGED SKIN AND ITS EFFECT ON REPAIR PROCESSES. Stajic, J.; Milovanovic, A.; Milivojevic, K.; Stojanovic, D.; Djukic, Z. Bull. Boris Kidric Inst. Nucl. Sci., 19: Biol., No. 3, 15-25(Nov. 1968).

The resorption rate of $^{137}CsCl$ through fresh excised skin wounds on the back of rats has been investigated as a function of time after contamination. The effect of contamination on the change in leukocyte counts in peripheral blood, on wound contraction dynamics and healing time has been studied. Results have shown that the resorption rate is highest during the first 20 minutes after contamination when the largest quantity of the contaminant penetrates into the organism. After this time the resorption intensity decreases sharply and after 70 minutes it remains almost at the same level. The changes in the leukocyte counts in peripheral blood of contaminated animals apparently differ from those in wounded controls. During the first 3 to 5 postoperative days the wound contraction dynamics is slower in contaminated animals than in the controls. No statistically significant difference in the healing time of the contaminated and non-contaminated wounds was found. (auth)

35911 PHAGOCYTIC FUNCTION OF THE RES IN STARVED RATS AFTER EXPOSURE TO LOW DOSES OF FRACTIONATED IRRADIATION. Antonijevic, Milos; Lalic, Vera. Bull. Boris Kidric Inst. Nucl. Sci., 19: Biol., No. 1, 1-7(Sept. 1968).

The effect of single and fractionated ^{60}Co γ irradiation on the phagocytic function of the RES in rats previously starved for 4 days was investigated. The starved animals were given a single dose of 300 R or fractionated doses of 3 × 100 R in 10-day intervals. Comparison of the phagocytic activity of the rats that received a single dose of 300 R after 4-day starvation and those that received the same dose in three fractions has revealed a difference: while the single dose of 300 R further increases the already raised global phagocytic index in 4-day starved nonirradiated rats, in rats that received an accumulated dose of 300 R of fractionated irradiation it is below that of the controls in the acute observation period. In the postacute period such behavior of the global phagocytic index is observed even on the 30th day, while later it showed a tendency to normalization in both groups of rats. (auth)

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Refer also to abstracts 35658, 35663, 35664, 35667, 35685, 35731, 35765, 35770, 35816–35818, 35826, 35943, and 35944.

35912 (ORAU-107, pp 16-18) THEORY OF QUANTITATIVE RADIATION-RESPONSE DATA. Bergner, Per-Erik E. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

A theory of quantitative radiation-response data is presented and discussed in relation to data on patients with chronic lymphocytic leukemia who were treated with whole-body 50 R and 100 R doses of γ radiation. The theory is constructed around the thought that average response data and the standard deviation can be calculated as a function of time. The purpose of the data analysis in terms of the theory was to determine how radiation effect and repair are related to each other. (C.O.)

35913 (ORAU-107, pp 18-20) STUDY OF THE MECHANISM OF SPLENIC IRRADIATION IN CHRONIC GRANULOCYTIC LEUKEMIA. Vodopick, Helen; Rupp, Elizabeth M.; Comas, Frank V.; Bergner, Per-Erik E.; Goswitz, Francis A.; Edwards, C. L. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

The mechanism by which splenic irradiation (^{60}Co γ) can effectively lower the blood leukocyte count in chronic granulocytic leukemia (CGL) was investigated. Leukokinetic studies using ^{32}P-labeled diisopropyl fluorophosphate (DFP) to label leukocytes under in vitro conditions were performed on patients with CGL. A decreased production of granulocytes appeared to be at least one of the main mechanisms accounting for the drop in the circulating white blood cells after splenic irradiation. (C.O.)

35914 (ORAU-107, pp 23-4) CYCLIC LEUKOCYTOSIS AND THROMBOCYTOSIS IN CHRONIC GRANULOCYTIC LEUKEMIA. Vodopick, Helen; Edwards, C. L.; Goswitz, Francis A. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Spontaneous fluctuation of the leukocyte count in chronic granulocytic leukemia (CGL) was observed in a female patient whose initial therapy consisted of ^{60}Co splenic irradiation, 10 fractionated doses (1,480 R) in 1965; ^{60}Co liver irradiation, 10 fractionated doses (1,480 R) in 1966; and ^{60}Co splenic irradiation 1 dose 785 R in 1967. Frequent blood counts revealed a cyclic fluctuation of both leukocyte and platelet counts that were in phase. The four cyclic changes observed lasted 66 days. Results of a bone marrow aspirate are discussed. (C.O.)

35915 (RLO-1780-24) EFFECTS OF IONIZING RADIATION ON THE TESTICULAR FUNCTION OF MAN. Six Year Summary Report, 1963-1969. Heller, Carl G. (Pacific Northwest Research Foundation, Seattle, Wash.). Apr. 1969. Contract AT(45-1)-1780. 56p. Dep. CFSTI.

Techniques were developed for quantitation of germinal cells and Leydig cells. Quantitative response of various germinal cell types to x radiation at dose levels of 10 to 600 R was determined. The ultrastructure of four types of human spermatogonia was studied using electron microscopy. It was found that the earliest spermatogonial recovery begins at approximately 150 days for all doses of radiation. In man, in contrast to mice and rats, following doses of 15 to 50 R, the surviving spermatogonia do not repopulate the entire seminiferous tubule, but after some renewal effort, quickly differentiate. At doses of 400 R and above, sperm morphology was severely damaged in the first 67 days after x radiation. Studies on hormones revealed that total gonadotropins were increased as the germinal epithelium was denuded following irradiation. It was shown that urinary follicle-stimulating hormone increases as the germinal epithelium was depleted following irradiation. Urinary interstitial-cell stimulating hormone did not increase following irradiation. Results of a radioimmunological determination showed a rise in plasma interstitial-cell stimulating hormone following irradiation. Leydig cell function appeared to be depressed by higher doses of irradiation as reflected by lowered urinary testosterone levels. (H.L.W.)

35916 CARCINOMA OF THE TONGUE AND FLOOR OF THE MOUTH. RESULTS OF RADICAL RADIOTHERAPY. Montana, Gustavo S.; Hellman, Samuel; Von Essen, Carl F.; Kligerman, Morton M. (Yale Univ., New Haven). Cancer, 23: 1284-9(June 1969).

A review was made of 104 cases of carcinoma of the tongue and floor of the mouth treated at the Hunter Radiation Center of the Yale New Haven Hospital from October 1958 through December 1966. This study was undertaken to determine the cure rates and complications of irradiation therapy in the management of this disease. The cure rates varied according to the location and stage of the tumor. The overall, corrected, cumulative 3-year survival was 45%. Serious complications developed in 5% of the patients. Twenty-six patients considered to be radiation failures underwent resectional surgery. The results of this study justify continuation of the approach thus far employed. To improve the cure rates, emphasis ought to be put on earlier detection of cases. (auth)

35917 GENERATION AND SAFE APPLICATION OF LASER BEAMS. Klost, W. Sicher Sicher, 18: No. 9-10, 217-19; 251-2(Sept.-Oct. 1967).

The nature of laser beams, their generation, and applications are described. Hazards of laser equipment for the eyes and skin and protective measures are discussed. These include electrical design and screening of equipment, workplace layout, training, medical supervision of personnel, and the use of goggles. (SICSA)

35918 COMBINED RADIATION AND BONE INJURY IN RATS, WITH SPECIAL REFERENCE TO THE MAST CELL COUNT IN THE PERIOSTEAL CALLUS. Lindholm, Ralf; Tamminen, Erkki; Autio, Eino; Lindholm, Sam (Univ. of Oulu, Finland). Acta Chir. Scand., 134: 613-16(1968).

To what extent the delay in fracture healing after total-body irradiation influences the mast cell reaction was studied. Immediately after x irradiation of rats with 400 or 800 R the right lower leg was manually fractured. The body weight curve showed only a slow rise in the group which received 400 R, while many animals which received 800 R lost weight. The mortality in the first group was 0; in the second group about 50% of the animals died from systemic disease. The dose of 800 R thus approached the sublethal range. The appearance of cartilage and bone components was only slightly delayed in both groups as shown by microscopic and radiographic examination. The callus area grew more slowly than normal and was clearly delayed in both groups. Consolidation of the fracture took place almost without retardation. The curves for mast cells per mm^3 fibrous callus tissue were compared with the control curve. The cell counts were high in the beginning, then subnormal until the third week of callus formation. The trend was almost the same in the 2 groups. The alterations in the mast cell reaction by irradiation indicate a disturbance in polysaccharide metabolism, leading to a moderate retardation of callus growth. (BBB)

35919 RADIATION REACTIONS WITH TELECOBALT IRRADIATIONS WITH FOCAL DOSES ABOVE 6000 R. Gosepath, J.; Diethelm, L.; Buchwald, W. Arch. Klin. Exp. Ohren-, Nasen-, Kehlkopfheilk., 191: 700-3(1968). (In German).

Irradiation effects in the ear, nose, and throat region from doses of 8000 R of ^{60}Co irradiation given to 105 patients were reported. Field sizes ranged from 30 to 100 cm^2. In a third of

the cases where large field sizes were used, serious skin and mucosal reactions resulted. These were treated with corticosteroids. It was found to be inadvisable to give cytostatic agents during irradiation because they seemed to increase the severity of the irradiation reactions. Xerostomia, soft tissue indurations in adipose patients, and a severe fibrosis of the masseter muscle were observed. No osteoradionecroses or cartilage necroses were observed. The histological characteristics of acute radiodermatitis were vascular dilatation, diapedesis, perivascular round cell infiltration, and hydropic degeneration of the skin. This was followed by disturbances of cell division and morphology in the basal and surface skin layers. Secondary, chronic radiodermatitis consisted of epidermal atrophy, acanthosis, dyskeratosis, dysplasia of the basal membrane, atrophy of the sebaceous and sweat glands, vascular obliteration, abnormal pigmentation, teleangiectases, and hyaline and clastoid degeneration of the corium. The changes were less marked than after x irradiation. The mucosa was ~30% more sensitive than the skin to ^{60}Co irradiation. Skin reactions were greater after a dose of 8000 R than after 6000 R. There were indications of recovery in skin and mucosal samples obtained from 6 to 16 months after irradiation, with evidence of scarification and atrophy. (BBB)

35920 RADIOLOGICAL HEALTH ASPECTS OF SPENT RADON SEEDS. **Bogge, Richard F.: Schmidt, Gail D.: Williams, Kenneth D. (Bureau of Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 10: 185-90(May 1969).**

Following three incidents of radiation exposure to jewelry contaminated with radioactivity, the Bureau of Radiological Health (BRH) examined the early development, present clinical use, and disposal of gold radon seeds, the suspected source of the contamination. The Ad Hoc committee called by the BRH to study the problem, recommended that; the State and local radiological health agencies that have regulatory authority over radon seeds be familiar with the appropriate regulations, that users of radon be advised to keep an account of radon seeds procured, not to supply unused or spent radon seeds to any unauthorized person, and to return all decayed or unwanted radon seeds to the supplier or persons authorized to receive such shipments, gold refiners and processors be alerted to the possibility of receiving contaminated gold and efforts should be made to prevent such material from entering the commercial market, the BRH consider the possibility of further investigation of the extent of the problem and consider providing technical assistance through appropriate agencies, and the medical community be encouraged to investigate the feasibility of using other radionuclides for permanent implants. (auth)

35921 DELAYED LESIONS IN THE TEETH AND THE MANDIBLE OF A CHILD AFTER THERAPEUTICAL X-RAY APPLICATION. **Perzyna, B.; Stawinski, K. Deut. Stomatol., 18: 908-12(Dec. 1968). (In German).**

A case of combined dysontogenesis of the mandible that had resulted from burns and subsequent correction of the cicatrices by means of ionizing radiation are described. Though it was not possible to obtain more detailed data on radiation type and dose, the clinical picture seems to be worth reporting with regard to sequelae and therapeutic difficulties. (auth)

35922 SKIN REACTIONS IN ELECTRON BEAM IRRADIATION. 1. MACROSCOPIC OBSERVATIONS. **Kamata, Rikisaburo; Haruyama, Kazuhisa (Nihon Univ., Tokyo). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1688-94(Mar. 1969). (In Japanese).**

Skin reactions produced by fractionated electron beam therapy are reported. The conditions of irradiation were as follows; Electron energy was varied from 6 to 26 MeV, and the total dose of irradiation was distributed from 4000 to 8000 R. The field size was varied from 30 to 200 cm^2. The skin of face, neck, chestwall, or axilla was irradiated. The dose was indicated by the Siemens Microchamber. The conversion factor of R to rad was 0.85 in the energy level of 14 MeV. The periods till the appearance of erythema were different between the group of 200 R/day and the group of 300 or 400 R/day. The period of the former group was 14 days and in the latter was 10 days. There was a slight difference in the speed of the appearance of erythema in the groups of different energy levels of irradiation, and erythema appeared more rapidly in the group of 26 MeV than the groups of 14 or 10 MeV. There was no difference in the speed of appearance of erythema in the different anatomic areas of the body nor difference in the speed in the different field sizes. The healing time of the lesion in the irradiated area was, however, prolonged in the group of the larger field size. The mean value of the dose to produce lesions was 7000 R but the lesions of the skin were easily healed. The RBE of the lesion dose was 0.85 at the level of 14 MeV. (NSA of Japan)

35923 BILATERAL RADIATION PNEUMONITIS, A COMPLICATION OF THE RADIOTHERAPY OF BRONCHOGENIC CARCINOMA. (REPORT AND ANALYSIS OF SEVEN CASES WITH AUTOPSY). **Bennett, Dale E. (Univ. of Texas School of Mecidine, San Antonio); Million, Rodney R.; Ackerman, Lauren V. Cancer, 23: 1001-18(May 1969).**

Acute radiation pneumonitis lacks any single pathognomonic morphologic feature, but is a diagnosis made from a combination of alveolar septal thickening, proliferation and desquamation of atypical septal cells, hyaline membrane formation, and pulmonary vascular changes. The pathogenesis of radiation pneumonitis is poorly understood. Total radiation dosage, total volume irradiated, and duration of therapy are significant factors but cannot explain all cases. Seven autopsied cases of bilateral radiation pneumonitis following megavoltage γ or x therapy for lung carcinoma are reported and analyzed. The use of extensive fields, or of rotational technique, necessitated irradiation of a large volume of lung tissue. The inaccuracy of calculated dosimetry, coupled with possible errors in port placement can result in much higher bilateral radiation doses than anticipated. Infection, by increasing absorption of radiation, probably causes an increased susceptibility to radiation pneumonitis. While the relatively small doses of radiation reaching the contralateral lung are usually innocuous, certain patients are hyperreactive and respond with a severe diffuse radiation pneumonitis. (auth)

35924 ACUTE THYROIDITIS, THYROID CRISIS, AND HYPOCALCEMIA FOLLOWING RADIOACTIVE IODINE THERAPY. **Freeman, Morris; Giuliani, Marguerite; Schwartz, Ernest; Gomprecht, Robert F. N. Y. State J. Med., 69: 2036-41(July 15, 1969).**

A patient with hyperthyroidism developed acute thyroiditis, thyroid crisis, and transient hypocalcemia five days after receiving a therapeutic dose of 3.5 millicuries of ^{131}I. Although the literature does not record definite association of thyroiditis and exacerbation of hyperthyroidism following ^{131}I therapy, it appears likely that exacerbation may be caused by thyroiditis, in many instances overt or occult, with release of thyroid hormone by damaged follicles. The finding of only modest elevation of the protein-bound iodine (8.4 micrograms per 100 ml.) in the patient and in three other patients recorded in the literature suggests that extrathyroidal factors may be important in the clinical picture of thyroid crisis. Excessive release of triiodothyronine or abnormal binding of thyroxine cannot yet be excluded in such cases. The occurrence of transient hypocalcemia five days following ^{131}I therapy is thought possibly to have been caused by the release of thyrocalcitonin from injured thyroidal tissue and/or inflammatory compromise of parathyroid function. Direct radiation damage to the parathyroid glands seems a less likely cause. (auth)

35925 EDEMA OF THE ARM AFTER SIMPLE MASTECTOMY AND RADIOTHERAPY FOR BREAST CANCER. **Tough, Ian C. K. (Lewis Hospital, Stornoway, Eng.). J. Roy. Coll. Surg. Edinburgh, 13: 312-14(Nov. 1968).**

Previous indications that irradiation and/or surgery may lead to arm edema after treatment for breast cancer are reviewed, and the problem was re-examined with reference to 573 new cases of breast cancer treated by simple mastectomy and radical radiotherapy and followed up for a minimum of 5 yr. Previous authors have considered radiotherapy a factor of importance in arm edema. Holman found a correlation with x-ray therapy but only when there had been a severe reaction. Treves likewise considered radiotherapy a significant factor, and Crile supported this contention. The occurrence of this complication in the present series in 5% of the patients confirms the findings of previous authors. (BBB)

35926 AUTOIMMUNE HEMOLYTIC ANEMIA AND THROMBOCYTOPENIA RESULTING FROM X-RAY AND CYTOSTATIC TREATMENT FOR LYMPHATIC LEUKEMIA. **Weinreich, J. (Medizinische Akademie, Luebeck). Allergie Asthma, 13: 264-6 (Dec. 1967). (In German).**

The possible role of antibody formation is discussed in development of autoimmune hemolytic anemia and thrombocytopenia observed in a patient treated for a lymphatic leukemia with x irradiation and Endoxan. Immunological complications from combined irradiation and cytostatic therapy are relatively infrequent, but the formation of antibodies may have been accentuated by the treatments used. Some possible relations between these factors and the symptoms presented by the patient are discussed briefly. (BBB)

35927 THYROID CARCINOMA ASSOCIATED WITH RADIATION THERAPY. **Harper, Paul V.; Paloyan, Daniel (Univ. of Chicago). Surg. Clin. N. Amer., 49: 57-60(Feb. 1969).**

This study reviews 47 cases of carcinoma of the thyroid in patients with a prior history of irradiation of the neck, face, and upper thorax. There was a predominance of females. The highest cancer incidence was in the 11- to 20-yr-old group, while 48% of

the patients in the entire group were less than 20 yr old at the onset of disease. Radiation doses to the face, neck, or upper chest ranged between 100 and 800 R; the estimated average dose was 150 R. More than half of the patients received x-ray therapy to the tonsils or thymus gland, and 30% of the patients were adolescents when treated with x-ray therapy to the face for acne vulgaris. The average duration of time between radiation exposure and onset of carcinoma was 12 yr; however, there was a range of 1 to 25 yr. There was predominance of carcinoma of the papillary type. Only 1 case of Huerthle cell carcinoma and none of the anaplastic variety were included. At the time of operation 36 of the patients, or almost 80%, had lymph node metastases. In 2 patients, surgical therapy for tumor recurrence in the neck was combined with prophylactic ^{131}I therapy, with good results. In the remaining patient, a case of mixed papillary-follicular carcinoma, ^{131}I therapy alone was effective in destroying regional tumor recurrences. Thyroidectomy and neck dissection (standard or modified) in the presence of lymph node metastases seem to be the best treatment for invasive papillary or follicular carcinoma of the thyroid associated with a history of radiation therapy. It was concluded that patients with prior history of radiation therapy to the neck or adjacent structures differ from the general population with carcinoma of the thyroid. (BBB)

35928 RADIATION INDUCED INTRACRANIAL MENINGIOMAS. Munk, J.; Peyser, E.; Gruszkiewicz, J. (Rambam Government Hospital, Haifa, Israel). Clin. Radiol., 20: 90-4(Jan. 1969).

Five cases of intracranial meningiomas, which developed after x irradiation of the scalp for tinea capitis many years previously, are presented. The skin of the scalp of all patients showed, in addition to permanent depilation, other marked late radiation changes. Four of the patients were operated upon and the histopathology was meningioma of meningo-endothelial type in three cases, and of fibroblastic type in one case. A review of radiation tumors in various tissues is presented and the mechanism of carcinogenesis in general and radiation carcinogenesis in particular is discussed, with the view to explain the supposed causative relationship between irradiation and these meningeal neoplasms. The importance of the stromal factor in irradiation carcinogenesis, resulting from early inflammatory or vascular occlusive changes and causing late tissue alteration in the course of chronic regenerative and reparative processes is stressed. The view is put forward that this tissue alteration, which opens the way for the autonomous and abnormal cell proliferation of tumors, may well be the common factor in carcinogenesis, whether the external stimulus is mechanical, chemical, or ionizing radiation. (auth)

35929 UROLOGICAL COMPLICATIONS IN RADIOTHERAPY OF GYNECOLOGIC CARCINOMA. Weghaupt, K. (Univ., Vienna). Urologe, 7: 253-6(Sept.-Oct. 1968). (In German).

The urological complications observed after radiotherapy of tumors of the uterine cavity were discussed. In general, they were similar to those seen after irradiation of vaginal or cervical tumors. After interuterine Ra treatments, other complications, such as mucopyometra or serometra were observed. Extension ruptures appeared after growth of the posterior bladder wall to the anterior wall of the uterus, and extensive hemorrhages resulted. Prior to this there was extensive bladder displacement and difficulties in micturition. Infrequently, mucopyometra was associated with recurrent tumor. Late irradiation injuries of the bladder were relatively infrequent because of the death of the patients prior to development of the injuries. Irradiation cystitis or ulcers were observed after Ra treatment, possibly because of concurrent diabetes mellitus or arteriosclerosis. Incidence of irradiation ulcers of the bladder after Ra treatment of the uterine tumors was 2.3%. After Ra treatment for cervical carcinoma the incidence of bladder ulcer was 1.3%. (BBB)

35930 CONTRIBUTION TO THE STUDY OF CARDIAC DAMAGE FOLLOWING ANTINEOPLASTIC RADIOTHERAPY. Ferri, G. G.; Dusi, U. (Univ., Padua). Quad Radiol., 32: 771-90(Sept.-Oct. 1967). (In Italian).

Study has been carried out by means of periodic clinical and electrocardiographical controls for about two years. In a group of 30 women, irradiated after left mastectomy, clinical and electrocardiographical signs indicating pericarditis were found. These were relatively young subjects with a previously undamaged cardiovascular system. In older subjects an aggravation (sometimes reaching a decompensation) of the signs of a pre-existing miocardiosclerosis was noticed. Analogous injuries, but with a very modest frequency, appeared in the 20 subjects irradiated after right mastectomy. Some indications of pericarditis (one of them was also checked from an anatomo-histological point of view) were also drawn from the less homogeneous group including variously located neoplasms, especially the left bronchial and mediastinic ones. Dosimetry for the radiant energy supplied in the course of the various treatments revealed a rather exact relation between the first symptoms of the cardiac injury and the entity of the dose absorbed by the heart. The pathogenesis of the injury, and its prevention and cure are taken into consideration. (C.O.)

Radiation Effects on Plants

Refer also to abstracts 35133, 35610–35612, 35633, 35656, 35684, 35691, 35698, 35699, 35775, 35778, 35839, 35853, 35943, and 35945.

35931 (BNL-13623) RADIOBIOLOGICAL STUDIES OF PLANTS ORBITED IN BIOSATELLITE II. Schairer, L. A.; Sparrow, A. H.; Marimuthu, K. M. (Brookhaven National Lab., Upton, N. Y.). [1969]. 10p. (CONF-690516-1). Dep. CFSTI.

From COSPAR Meeting, Prague, Czechoslovakia.

The Biosatellite II Tradescantia experiment probed the effects of the space environment on spontaneous and radiation-induced mutation rates and on cytological changes in Tradescantia clone 02. Thirty-two yound flowering plants were arranged in a plastic housing with the roots immersed in nutrient solution, were exposed to gamma radiation from an on-board ^{85}Sr source during the two-day orbital flight. Unirradiated plants were flown in a package in the spacecraft behind a tungsten radiation shield and identical nonflight control packages (with and without irradiation) were maintained at the launch site. After retrieval of the spacecraft near Hawaii, samples of root tip, ovary, and stamen tissues were collected. These and the intact plants were flown to Brookhaven for observations on the following endpoints: somatic mutation, cell size, loss of reproductive integrity resulting in stunted stamen hairs, pollen grain mortality, frequency of micronuclei in pollen, disturbed mitotic spindle function and chromosome aberrations. Analysis of data on somatic mutation, cell size, and chromosome aberrations endpoints showed no significant differences between flight and nonflight samples. However, pollen abortion, frequency of micronuclei in pollen, and loss of reproductive integrity (stamen hair stunting) showed increases associated with weightlessness in irradiated material. Root tip and microspore cells showed effects of disturbed mitotic spindle function in orbited plants both with and without irradiation. Clearly differences exist between flight and nonflight material and the significance and possible mechanisms for these effects are being studied in continuing nonflight tests. (auth)

35932 (JPRS-47582, pp 21-8) COMBINED EFFECT OF SPACEFLIGHT FACTORS ON THE "KOSMOS-110" ARTIFICIAL EARTH SATELLITE ON PLANTS. Gertsuskii, D. F.; Petrovnin, M. G.; Alekseenko, L. V. Translated from Kosm. Biol. Med., 2: No. 6, 17-21(1968).

Data characterizing the effect exerted on plants by spaceflight factors involved in the flight of the Kosmos-110 biosatellite are presented. The plants grown from seeds flown aboard the Kosmos-110 biosatellite grew and developed faster, giving a higher yield than the controls. In comparison with the controls on earth the flight plants contained larger amounts of ascorbic acid and a higher percentage of water, although the sugar content was similar. These results cannot be attributed solely to the effect of ionizing radiation. They appear to be a combined result of space factors involved in the "Kosmos-110" flight. (auth)

35933 (ORO-2066-13) EFFECTS OF GAMMA RADIATION ON TREE SEED AND SEEDLINGS. Heaslip, Margaret B. (Morehead State Univ., Ky.). [1969]. Contract AT(40-1)-2066. 27p. Dep. CFSTI.

Separate abstracts were prepared on the three sections of this report. The three papers discuss the growth and survival of irradiated tree seedlings planted in a secondary forest, the growth of pine seedlings planted over nuclear waste disposal pits, and the relative γ-radiosensitivity of seed collected from trees grown from irradiated and nonirradiated seed. (E.R.B.)

For abstracts of individual sections see: 35934–35936.

35934 (ORO-2066-13, pp 1-10) GROWTH PATTERNS AND SURVIVAL OF IRRADIATED TREE SEEDLINGS PLANTED IN A SECONDARY FOREST. (Morehead State Univ., Ky.).

The growth patterns and survival of γ-irradiated seedlings of Quercus alba (white oak), Juglans nigra (black walnut), and Fraxinus americana (white ash) planted in a secondary forest in competition with both irradiated and nonirradiated seedlings and exposed to naturally occurring environmental stress were studied. On the basis of seedling survival and general vigor of surviving seedlings, ash was the most resistant to γ irradiation and white oak the most sensitive to γ irradiation. Survival of all three species decreased as the rate of radiation increased and ash and white oak seedlings dormant at the time of irradiation

were obviously more resistant to γ rays than the physiologically active seedlings. Walnut appeared to be less radiosensitive when physiologically active; however, most of this growth was from root sprouts that developed after the irradiated stems died and the auxin concentration dropped. (E.R.B.)

35935 (ORO-2066-13, pp 11-18) GROWTH RESPONSE OF PINE SEEDLINGS PLANTED OVER NUCLEAR WASTE DISPOSAL PITS. (Morehead State Univ., Ky.).

Three species of pine, Pinus echinata (short leaf pine), P. strobus (white pine), and P. virginiana (Virginia pine) were planted over nuclear waste disposal pits. Maximum surface readings over the closed pits were 10 to 20 mR/hr. Alpha and γ activity in seedlings were not detectable, but β activity was measurable in the ash of white and Virginia pines indicating some radioactive leakage or radioisotope movement in the burial area. (E.R.B.)

35936 (ORO-2066-13, pp 19-26) RELATIVE GAMMA SENSITIVITY OF SEED COLLECTED FROM TREES GROWN FROM IRRADIATED AND NONIRRADIATED SEED. (Morehead State Univ., Ky.).

Seeds of red bud trees were collected from control and irradiated trees and subjected to ^{60}Co γ irradiation. Percent germination, percent survival, and the two percents transformed by arc sine transformation were determined. The significance of these four variables in the determination of parent-offspring interactions is discussed. (E.R.B.)

35937 INTERPHASE CHROMOSOME VOLUME-RADIOSENSITIVITY RELATIONSHIP IN SOME DIPLOID ANNUALS. Sur, S. C. (Fertilizer Corp. of India Ltd., Sindri). Technology (Sindri), 5: 208-12(July-Sept. 1968).

Eleven diploid annuals were investigated in a gamma field with lethality and growth inhibition as the criteria of radiation damage. Growth inhibition was determined at two levels, i.e., severe (85% reduction) and slight (15 to 20% reduction). Growing plants were chronically irradiated approximately 10 hr a day for eight to 12 weeks, from seedling stage to maturity. The dose rate required to induce a desired effect was taken as a measure of radiosensitivity. For equivalent effects in different species, the dose rates showed negative correlations with nuclear volumes (e.g., −0.664 between nuclear volume and lethality). The correlations were better with interphase chromosome volumes (ICV): −0.720 between ICV and lethality, −0.729 between ICV and severe growth inhibition, and −0.779 between ICV and slight growth inhibition. These observations confirm Sparrow's suggestion regarding the possibility that the radiosensitivity of other plant species can be predicated if their ICV values are known. (auth)

35938 RADIOPROTECTIVE PROPERTIES OF SOME ANTIBIOTICS APPLICABLE TO PLANTS. Ilyina, G. V.; Kuznetsova, N. N.; Rydkii, S. G. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. VI, Biol. Pochvoved., No. 1, 56-63(1968). (In Russian).

A fungus, Trichothecium roseum, used as a source of an antibiotic and antifungal agent, was studied with respect to radioprotective properties applicable to spring wheat. Experiments on the effects of T. roseum extracts at various concentrations (1:1000, 1:2000, 1:5000, 1:12,500 and 1:25,000) on germination of wheat seeds revealed that, initially, the higher the concentration, the stronger was the inhibition effect on the germination and on the height of sprouts. However, treated plants examined after one month showed no traces of the presence of the antibiotic. In the 2nd series of experiments one group of wheat seeds was soaked for 20 min in water and another group received a 20-min pretreatment with 1:10,000 and 1:25,000 concentrations, whereupon both groups were irradiated with a 1500 R dose using a ^{60}Co γ source at 243 R/min (some seeds were not irradiated). Irradiated wheat seeds developed into mature plants much later than the nonirradiated ones. The strongest retardation was noted in plants grown from irradiated seeds previously immersed in water, while the plants that developed from irradiated seeds treated with T. roseum antibiotic demonstrated a far milder retardation. The earliest appearing fruiting spikes were those on nonirradiated water-treated plants, while similarly pretreated but irradiated plants failed to develop fruiting spikes. Most of the samples irradiated and pretreated with 1:10,000 concentrations developed fruiting spikes, but irradiated species pretreated with a 1:25,000 concentration failed to produce fruiting spikes. (BBB)

35939 ROLE OF WATER CONTENT IN THE DECAY OF RADIATION-INDUCED OXYGEN-SENSITIVE SITES IN BARLEY SEEDS DURING POST-IRRADIATION HYDRATION. Conger, B. V.; Nilan, R. A.; Konzak, C. F. (Washington State Univ., Pullman). Contract AT(45-1)-353. Radiat. Res., 39: 45-56 (July 1969). (RLO-353-24).

Himalaya barley seeds ranging in water content from 1.2 to 12.8% were exposed in vacuo to 25 kRads of ^{60}Co γ rays. After irradiation they were hydrated in either oxygenated or oxygen-free water at 0°C for various periods of time before transfer to the opposite hydration atmosphere or before the free radical signal was measured by EPR. Radiobiological damage was measured in terms of seedling injury, and the EPR data are presented in terms of signal amplitude. The results showed that the development of oxygen-dependent damage occurs faster than the rate at which oxygen-sensitive sites are lost during the postirradiation hydration process. Although seed water content influenced the initial and final injury levels, this factor appeared to have little influence on the above-mentioned rates. Data obtained by EPR techniques indicate the possibility of at least two radical components. Furthermore, there was a sizable signal remaining in the irradiated seeds even after 16 hr of hydration. The data also suggest that the hydration of macromolecules within the cell may be the rate-determining process in the decay or quenching of radioinduced oxygen-sensitive sites, and intermediate products or processes may be involved in the development of oxygen-dependent damage. (auth)

35940 STUDIES ON INDUCING MUTATION BY RADIATIONS. 2. RADIOSENSITIVITIES OF SEVERAL ORNAMENTAL PLANTS. Shimazu, Nariyasu; Onozawa, Yoshiro (Ibaraki Univ., Japan). Ibaraki Daigaku Nogakubu Gakujutsu Hokoku, No. 16, 1-5(Oct. 1968). (In Japanese).

In order to estimate effective dosages of x- or γ-irradiation for mutation breeding, radiosensitivities of several ornamental plants, i.e. niwaume (Prunus japonica Thunb), cactus species, salvia (Salvia splendens), omoto (Rhodea japonica Roth), and orchid hybrid, were examined. Results were as follows. In the 120 days chronic irradiation to the winter bud of niwaume, bud mutations were expected at doses from 10 to 25 kR. Lethal dose fifty (LD 50) in cactus was estimated at 40 to 50 kR in acute γ irradiation of dormant seeds, and 3 to 4 kR in acute γ irradiation of seedlings. It was suggested that reasonable doses were 1.5 to 2.0 kR in 82 days chronic γ irradiation during the flowering period of salvia, and about 2.0 kR in acute γ irradiation to the seedlings of omoto and orchid. (NSA of Japan)

35941 THE GROWTH OF NORMAL AND DWARF MUTANT BEAN PLANTS (PHASEOLUS VULGARIS, L., VAR. MEXICO 80-R GROWN IN SOLUTION. Proano, Victor; Greene, George L. (IICA, Turrialba, Costa Rica). Turrialba, 18: 75-6(Jan.Mar. 1968). (In Spanish).

The growth of normal and dwarf mutant bean plants (Phaseolus vulgaris L., var. 'Mexico 80-R') was compared as part of a preliminary study to investigate the content of gibberellin-like substances in these plants. To determine the difference in the growth between the normal and dwarf mutant bean plants, seedlings were grown in Hoagland's solution No. 2 in glass flasks and then measured. The greatest growth difference was found in the second internode length. The dwarf mutant's growth was inhibited after the formation of the second internode, apparently due to the lack of the gibberellin-like substance necessary for normal growth. It was found that both the dwarf mutant and the normal plants, on oven-drying, lost an equal amount of water in relation to the total plant, however the normal plant lost a greater percentage of moisture as compared to the dwarf, when equal samples were weighed. (auth)

35942 SOME FACTORS AFFECTING THE RADIOSENSITIVITY OF MOLDS. Muenzner, Ruth (Lebensmittelfrischhaltung, Karlsruhe, Ger.). Arch. Mikrobiol., 64: 349-56(Jan. 30, 1969). (In German).

The influence of the growth media, incubation temperature, and age of the cultures on the radiation sensitivity of different strains of Penicillium viridicatum and Aspergillus flavus is described. Irradiation of the conidia took place on agar plates at 25°C with 10-MeV electrons provided by a linear accelerator. Doses from 80 to 160 krad were used. The media used included potato-dextrose agar, Sabonraud agar, malt extract agar, and Czapek agar. The recovery of irradiated conidia was higher on optimal media. The recovery of irradiated conidia of A. flavus was favored by optimal incubation temperature, while those of P. viridicatum showed the highest relative growth rates at suboptimal temperatures. The radiosensitivity of the conidia increased with age. Actively growing cultures of the molds were more sensitive to radiation than older ones. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 35184, 35190, 35637, 35688–35690, 35695, 35700, and 35839.

35943 (ORAU-107, pp 46-51) STUDIES ON THE MICROFLORA OF PATIENTS EXPOSED TO 250-R TOTAL-BODY IRRADIATION IN THE LETBI FACILITY, 1.5 R/hr. Balish,

Edward; Pearson, Ted A. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Microflora (bacteria and yeast) isolated from the nares, gastric washings, rectal swabs, and urine specimens of two patients exposed to 250 R whole-body irradiation in the low-exposure rate cobalt-60 γ facility at the rate of 1.5 R/hr are discussed. Findings are presented in tabular form. One patient was suffering from polycythemia vera and the other from a reticulum cell carcinoma. (C.O.)

35944 (ORAU-107, pp 52-9) STUDIES ON THE MICROFLORA OF THREE MEN ACCIDENTALLY EXPOSED TO TOTAL-BODY IRRADIATION. Balish, Edward; Pearson, Ted A. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Studies on the microbial flora (bacteria and yeast) of the nose, throat, skin, urine, and stool specimens of three men exposed to high levels of x radiation generated by a Van de Graaff accelerator were carried out. Total-body dose estimates for two of the men were 500 to 600 R and 100 to 200 R for the third. The studies were started 12 days after exposure. Findings are presented in tabular form. The differences in results between the low-dose patient and high-dose patients are discussed. (C.O.)

35945 (ORAU-107, pp 65-8) STUDIES ON THE MICROFLORA OF TWO PATIENTS EXPOSED TO PARTIAL-BODY IRRADIATION. Balish, Edward; Pearson, Ted A. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

A patient treated with 4800 rads (partial-body) irradiation to hip and shoulder over a period of 17 days developed high fever. During this period, the microflora of the nose, throat, sputum, and rectum was determined. The only unusual finding in the specimens was a Candida species (not C. albicans) in the sputum. The microflora of another patient treated with 242 rads of splenic irradiation was also considered. Data on both patients are presented in tabular form and are briefly discussed. (C.O.)

35946 (ORAU-107, pp 68-70) STUDIES ON THE MICROFLORA OF RATS EXPOSED TO 1400 RADS TOTAL-BODY IRRADIATION. Balish, Edward; Pearson, Ted A.; Comas, Frank V. (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

Bacterial profiles of the stomach, small intestine, and colon of rats 6 and 12 days after exposure to 1400 R whole-body irradiation were determined. Data are presented in tabular form and are discussed. Significant alterations in the microflora of stomach contents occurred at 12 days; colon contents did not show any appreciable change in bacterial composition. (C.O.)

35947 (ORAU-107, pp 71-4) ISOLATION OF A SPHAEROPHORUS-TYPE MICROORGANISM FROM THE STOOL OF TWO PATIENTS. Pearson, Ted A.; Balish, Edward (Oak Ridge Associated Universities, Inc., Tenn. Medical Div.).

A Sphaerophorus-type microorganism was isolated from the feces of two cancer patients after cobalt radiation therapy. The anaerobic fecal microflora of these two patients is presented in tabular form. Initial isolation and characterization procedures are described and discussed. (C.O.)

35948 THE INABILITY TO ALTER LIMITED HETEROCATALYTIC EXPRESSION IN PHAGE T4-INFECTED ESCHERICHIA COLI BY GROWTH OF HOST CELLS UNDER VARIOUS PHYSIOLOGICAL CONDITIONS. Snustad, D. Peter (Univ. of Minnesota, St. Paul). Virology, 38: 361-4(June 1969).

Limited heterocatalytic expression of phage T4 was examined in cells grown on starvation buffer for two hours, on M9 acetate and M9 succinate for 20 hours or longer, and uv-induced filaments grown on H-broth for two hours after irradiation. The basic experimental approach involved mixedly infecting the restrictive host with a constant, low multiplicity of T4D wild type, and varying multiplicities of the respective mutant and determining the number of infected bacteria yielding bursts by plating infective centers on the appropriate restrictive host. Wild type expression was then estimated by determining the proportion of wild type infected cells yielding bursts by comparison with the control tube singly infected with wild type. Results are presented in graphic form. (H.L.W.)

35949 RESIDUAL INFECTIVITY AND THE EXTENT OF PHOTOREACTIVATION IN THREE DIFFERENT HOST PLANTS OF UV-IRRADIATED POTATO VIRUS X. Govier, D. A.; Kleczkowski, A. (Rothamsted Experimental Station, Harpenden, Eng.). J. Gen. Virol., 4: 347-54(Apr. 1969).

Dark reactivation of uv-inactivated potato virus X was studied. The source of radiation was a low-pressure mercury lamp, with a filter to eliminate radiation of wavelength shorter than 240 nm, so that most of the radiation was of the wavelength of 253.7 nm. Residual infectivities of the uv-irradiated virus were assayed on three different kinds of plants. When the plants were kept in darkness to prevent photoreactivation of the inactivated virus, the residual infectivity appeared the same whether Chenopodium amaranticolor or either of two varieties of tobacco was used for assay. When the plants were exposed to daylight, photoreactivation occurred in all three kinds of plants, possibly to a somewhat greater extent in Chenopodium than in tobacco plants. Thus, in contrast to the results previously obtained with tobacco necrosis virus, no evidence was obtained for dark reactivation of uv-inactivated potato virus X in Chenopodium. In the absence of photoreactivation, the quantum yields for inactivation were 0.8×10^{-3} and 1.3×10^{-3} for the whole virus and for the RNA inside the virus, respectively. (BBB)

35950 MICROBIAL HYDROCARBON CO-OXIDATION. III. ISOLATION AND CHARACTERIZATION OF AN α, α'-DIMETHYL-cis-MUCONIC ACID-PRODUCING STRAIN OF NOCARDIA CORALLINA. Jamison, V. W.; Raymond, R. L.; Hudson, J. O. (Sun Oil Co., Marcus Hook, Pa.). Appl. Microbiol., 17: 853-6 (June 1969).

A soil isolate identified as a uv-radioinduced strain of Nocardia corallina accumulated α,α'-dimethyl-cis,cis-muconic acid under co-oxidation conditions employing n-hexadecane for growth and p-xylene as the co-oxidizable substrate. N. corallina V-49 was postulated to have two pathways for the oxidation of p-xylene. One pathway proceeds through p-benzyl alcohol, p-tolualdehyde, and p-toluic acid to 2,3-dihydroxy-p-toluic acid, and the other pathway results in ortho ring cleavage of 3,6-dimethylpyrocatechol and hence accumulation of α,α'-dimethyl-cis,cis-muconic acid. (auth)

35951 SURVIVAL OF ESCHERICHIA COLI B IRRADIATED WITH GAMMA RAYS AND ALPHA PARTICLES. Myasnik, M. N.; Korogodin, V. I.; Petin, V. G.; Morozov, I. I. (Inst. of Medical Radiology, Moscow). Dokl. Akad. Nauk SSSR, 185: 932-4(Apr. 1, 1969). (In Russian).

The survival of E. coli B irradiated with gamma rays or alpha particles from polonium-210 was determined at the same time by growing the cells under the same conditions before and after irradiation. Eighteen-hour cultures grown on wort agar or on fish agar were irradiated as a monolayer. Control and irradiated cells were placed in Petri dishes, and were incubated at 37 and 42°C. The survival was determined by counting the macrocolonies after 24-hour incubation. The survival of cells grown on wort agar before irradiation with subsequent culturing on fish agar at 42°C is significantly higher than at 37°C regardless of whether the bacteria are irradiated with gamma rays or alpha particles. Hence the increased survival at 42°C is determined not by the type of radiation but by the conditions under which the cells were raised before irradiation. It is hypothesized that the filamentous-type of E. coli that are often nonviable are not encountered as often at 42°C as they are at 37°C. Growing of cells on wort agar before irradiation significantly increases the frequency of filament formation in the postradiation period. Thus the variation in survival of E. coli B at various temperatures of postradiation culturing is associated with the frequency of filament formation and is determined by the conditions of raising the cells before and after irradiation, and not by the type of radiation. (TTT)

35952 VIRUSES AND MAMMALIAN CHROMOSOMES. IX. THE CAPACITY OF UV-IMPAIRED ADENOVIRUS TYPE 18 TO INDUCE CHROMOSOME ABBERATIONS. Stich, H. F.; Avila, Lucrecia; Yohn, D. S. (Univ. of British Columbia, Vancouver. Roswell Park Memorial Inst., Buffalo). Exp. Cell Res., 53: 44-54(Oct. 1968).

The effects of uv radiation on the ability of human adenovirus 18 to induce chromosome aberrations in cultured hamster cells (BHK-21), wherein virus replication does not occur and in human cells (HEp-2), that support the replication of adenovirus 18 were investigated. Other parameters influenced by uv irradiation that were examined included viral infectivity, viral antigen synthesis, and neoantigen formation. Results showed that exposure to uv radiation did not significantly alter the capacity of the virus to induce chromosome aberrations and had only a slight effect on neoantigen synthesis. (C.H.)

35953 INTERACTION OF X RAY, ULTRAVIOLET LIGHT, AND THYMINELESS INCUBATION IN KILLING 5-BROMODEOXYURIDINE-GROWN BACTERIA. Ganguli, Nati; Bhattacharjee, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Radiat. Res., 39: 126-34(July 1969).

The sensitivity to x rays and uv light of a thymine-requiring mutant of Escherichia coli, grown in the presence of 5-bromodeoxyuridine, was determined after different periods of thymine starvation. The effect of previous irradiation of the cells with either x rays or uv light on thymineless incubation was also observed. It was found that the bromodeoxyuridine-induced radiosensitization (both to x rays and to uv light) could be reversed by previous thymine starvation. The bromodeoxyuridine-substituted cells preirradiated either with x rays or with uv light showed a

greater percentage of cells that were more resistant to the lethal action of thymineless incubation than the unirradiated population. (auth)

35954 CYTOTOXIC EFFECT OF FOWLPOX VIRUS ON PRIMARY HUMAN AMNIOTIC CELL CULTURES. Burnett, J. W. (Univ. of Maryland, Baltimore); Frothingham, T. E. Arch. Gesam. Virusforsch., 24: 137-47(1968).

The effect of uv radiation on infectivity and cytotoxicity was examined in a study of the cytotoxic effect of fowlpox virus on human amnion cells. The cytotoxic and infective properties of fowlpox suspensions were affected in the same way by a variety of physical and chemical procedures. Ultraviolet irradiation (provided by Model SL 2537, Ultraviolet Products Inc., South Pasadena, Calif.), however, destroyed infectivity at a greater rate than cytotoxicity, and ultrasound increased the cytotoxicity titer more regularly and to a greater degree than infectivity. Several hours of contact between virus suspension and cells are needed for cytotoxicity to ensue. Suspensions that were cytotoxic nearly always contained at least 10^3 plaque-forming units (PFU)/ml. Titers of both properties fell to undetectable levels during 30 days in human amnion cell culture. Titers of both properties were also reduced by centrifugation, filtration, heat, acid, chloroform, and ether. Treatment with ultrasound regularly increased cytotoxicity titer; infectivity increased to a much smaller and less predictable degree. Cytotoxicity-neutralizing serum antibodies developed in guinea pigs inoculated with fowlpox virus. Cytotoxicity was identical in normal and 5-iodo-2'-deoxyuridine (IDUR)-treated human amnion cells, but no plaques appeared in IDUR-treated chick embryo cells. The data suggest a mechanism of cytotoxicity that requires contact between virus and cell that does not require assembly of infectious viral particles. (BBB)

35955 PULSE-IRRADIATED BACTERIAL SURVIVAL IN THE PRESENCE OF NITRIC OXIDE. Dewey, D. L.; Michael, B. D. (Mount Vernon Hospital, Middlesex, Eng.). Radiat. Res., 39: 82-9(July 1969).

Nitric oxide gas, like oxygen, sensitizes biological material to ionizing radiation. Also, like oxygen, the nitric oxide is used up during irradiation. Thus, when the total dose is delivered in 2 microseconds, the annitricoxic radiosensitivity is observed for part of the dose. Unlike oxygen, there is a post-nitric oxide treatment effect at both low and high dose rates. Also, unlike oxygen, high concentrations of nitric oxide fail to sensitize at low dose rates, but do sensitize at high dose rates. (auth)

35956 RECOVERY OF MICROORGANISMS FROM THE EFFECTS OF IONISING RADIATION. Hughes, D. E. (University Coll. of Cardiff, Wales). pp 409-23 of Energetics and Mechanisms in Radiation Biology. Phillips, Glyn O. (ed.). London, Academic Press, 1968.

From Conference on Energetics and Mechanisms in Radiation Biology, Portmeirion, Wales. See CONF-670422.

Reference is made to the apparent discrepancies when different methods are used to estimate the post-irradiation recovery of viable bacteria, and it is suggested that the discrepancies are related mainly to the availability of material derived from lysed cells; such material can aid recovery of organisms and under some conditions can restore reproduction to the same level as normal cells. The discrepancies cause marked differences in apparent radiosensitivity, especially when organisms are recovered in a liquid rather than a solid medium. Criteria for the measurement of survival and recovery of irradiated living organisms differ in various systems. A distinction is made between microorganisms that are viable in the sense of ability of individual cells to reproduce and form colonies and in the sense of ability to grow, but not reproduce. The latter may appear as genetically stable mutants whose mode of cell division is somewhat uncertain and who can show considerably enhanced radiation resistance after several cycles of irradiation and recovery. The subject is discussed under the following headings; measurement of viability; measurement of growth; continuous culture; experimental work (measurement of sensitivity of microorganisms to ionization radiations, measurement of radiation effects on growth, growth curves of irradiated cells, lysis of irradiated cells, and effect of lysates on the growth of irradiated cells). (UK)

35957 ACTION OF UV-INACTIVATED SENDAI VIRUS ON RNA SYNTHESIS IN ASCITES CELLS. Botich, S.; Vladimirtseva, E. A.; Bukrinskaya, A. G. (Inst. of Virology, Moscow). Biokhimiya, 34: 78-83(Jan, 1969). (In Russian).

Synthesis of RNA was studied in cells incubated with uv-inactivated virus to determine the role of infectivity of the virus in inhibition of cell RNA synthesis. It was shown that uv-inactivated virus inhibits RNA synthesis to the same extent as active virus. In contrast to active virus, uv-inactivated virus stimulated formation of stable messenger RNA which sedimented at 27S. Treatment of the cells with actinomycin completely blocked synthesis of this RNA and inhibited formation of all host cell RNA fractions. Treatment of the cells with uv-inactivated virus in a concentration which was equivalent to 1000 and 25000 EID_{50} per cell yielded the same results as when the concentration was equivalent to 100 EID_{50} per cell. However, the higher concentration inhibited the synthesis of ribosomal RNA and stimulated the synthesis of messenger RNA 30 min after infection, while the lower concentration acted only after 3 hr. These findings indicate that inhibition of the synthesis of cell RNA during the infection of the cells by the virus with superinfective doses is associated mainly with the structural components of virus particles. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstracts 35181, 35632, 35643, 35856, and 35859.

35958 (AAEC/TM-502) MICROBIOLOGICAL AND ORGANOLEPTIC EVALUATION OF AUSTRALIAN FISH IRRADIATED AND STORED AT 0°C. Siagian, E. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). May 1969. 18p. Dep.

To study the effects of gamma irradiation on some species of Australian fish, samples of flathead (Platycephalidae) and nannygai (Trachichthodes affinis) were gamma-irradiated aerobically at 0°C in polyethylene bags at a dose of 1.65×10^5 or 3.30×10^5 rads and stored for several weeks at 0°C. The initial bacterial load ranged from 10^4 to 10^6 bacteria and 10^2 to 10^4 moulds per cm^2 skin or per gram muscle. No yeasts could be found either before or after irradiation. Radiation reduced the number of microorganisms 10- to 5000-fold, the degree of inactivation being influenced by species and preparation of the samples. The majority of the bacteria initially found on the fish were from the gram-positive species Micrococcus, Microbacterium, and Corynebacterium. After irradiation, the proportions of these species present on the fish altered with storage. The main gram-negative species isolated initially were Flavobacterium and Pseudomonas. Although these organisms continued to flourish in the untreated fish during the storage period, they were not present at the end of storage of the irradiated fish, when the only gram-negative species detected were Achromobacter and an unidentified species. After 21 days' storage at 0°C, the irradiated gutted flathead were organoleptically acceptable, while after 26 days' storage at 0°C, flathead fillets given the lower radiation dose were considered to be marketable. (auth)

35959 FOOD IRRADIATION. Proceedings of a Seminar held at Trombay, January 13–14, 1969. Trombay, India, Bhabha Atomic Research Centre, 1969. 112p. (CONF-690117).

Separate abstracts were prepared for 18 papers presented at the conference. (H.L.W.)

For abstracts of individual papers see: 35960–35977.

35960 IRRADIATION AS A FOOD PROCESS. Urbain, Walter M. (Michigan State Univ., East Lansing). pp 1-6 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Minimum dose requirements are discussed with regard to legal requirements, practical considerations, and costs. Storage conditions and protective packaging of irradiated foods are considered. Factors determining the choice of radiation employed are discussed. The importance of shielding workers and the training of research workers and assistants are discussed. (H.L.W.)

35961 FOOD IRRADIATION PROGRAMME OF THE JOINT FAO/IAEA DIVISION OF ATOMIC ENERGY IN FOOD AND AGRICULTURE. de Proost, M. (IAEA, Vienna). pp 7-15 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

A program for the application of ionizing radiation to problems of food preservation and processing is described. The use of radiation for the following processes is outlined: disinfestation of grain, radicidation (destruction of microorganisms and parasites in food), radurization (reduction of bacterial populations in order to prolong the market life of perishable food products), and radappertization (production of stable products by sterilization of highly resistant spores). Training of personnel and development of equipment for research in food irradiation are discussed. Legislation and clearance of irradiated food for inter-

national trade are examined. A table is presented to show irradiated food products cleared for human consumption in Canada, Israel, United States, and the Soviet Union. A coordinating center for collecting wholesomeness and legislative data on irradiated food is described. (H.L.W.)

35962 PLANNING A FOOD IRRADIATION RESEARCH PROGRAMME. Goresline, Harry E. (International Atomic Energy Agency, Vienna). pp 16-18 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

The importance of considering economic problems of handling and distribution of irradiated food before basic research is undertaken is discussed. The experimental design should be discussed with statisticians before research is begun. The conditions under which experiments are to be run should be established and adhered to at all times. Factors to be taken into consideration are the radiation source, its geometry, the dosimetry, and the dose distribution. (H.L.W.)

35963 REPORTS ON BARC PROGRAMMES IN FOOD IRRADIATION: GENERAL OBSERVATIONS. Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 19-20 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Four aspects of the program were emphasized: grain disinfestation, sprout inhibition in potatoes and onions, shelf life extension in sea foods and other meats, and delayed ripening in mangoes and bananas. Studies on wholesomeness testing included sensory evaluation, nutritional value, microbiological safety, and freedom from toxic effects. Geographical factors, seasonal distribution, and other local problems were considered in the development of the program. The importance of cooperating with other ministries of the government were emphasized. (H.L.W.)

35964 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: STATUS OF PROJECT ON GRAIN DISINFESTATION WITH GAMMA RAYS. Rahalkar, G. W.; Lewis, Anne J. (Bhabha Atomic Research Centre, Trombay, India). pp 21-3 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

The relationship between stage of development of the insect and radiosensitivity is discussed. Experiments were conducted on the response of various developmental stages of insects to doses of 5, 10, 15, and 20 Krads. Insects used were the rice weevil, lesser grain borer, khapra beetle, red flour beetle, fig moth, rice moth, and the pulse beetle. A smaller dose is required by immature stages to produce the same end result. It was shown that little difference exists between species in radiosensitivity; the recommended minimum effective dose for commercial use is 16,000 rads. Studies on the effects of temperature indicated that while the larvae were maintained at a lower temperature after irradiation, no mortality occurred. (H.L.W.)

35965 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: STATUS OF PROJECT ON PRESERVATION OF POTATOES AND ONIONS BY SPROUT INHIBITION. Dharkar, Shri S. D. (Bhabha Atomic Research Centre, Trombay, India). pp 24-7 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Combined effects of skin coating and irradiation on potato tubers were studied. Potato tubers were dipped in a skin-coating emulsion consisting of distilled acetylated monoglyceride. The skin coated and irradiated tubers lost only 8% moisture as compared with 32% in the untreated control, 24% in the non-skin-coated irradiated group, and 19% in the skin-coated control. After storage for 30 days there was sudden initiation of sprouting in the control group. Effects of temperature and humidity were also studied. Onions were irradiated and stored at room and cold (10°C) temperatures. Nearly all of the control bulbs stored at room and cold temperatures sprouted within two and one half months and were spoiled within six months, while the irradiated bulbs were still in marketable condition. Other studies were conducted on microbial toxicity in irradiated potatoes. (H.L.W.)

35966 STATUS ON ECONOMICS OF POTATO AND ONION PRESERVATION BY USE OF IRRADIATION. Karnik, K. S.; Jogiekar, P. N. (Dept. of Atomic Energy, Bombay). pp 28-34 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Economic losses of potatoes and onions resulting from sprouting, dehydration, and spoilage are discussed. The maximum and minimum prices and the range of cold-storage costs and irradiation costs per ton of potatoes and onions are considered. One favorable factor is the production of potatoes and onions in a few compact locations. The possibility of using the irradiator for other commodities is discussed. (H.L.W.)

35967 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: STATUS OF PROGRAMME RELATING TO PRESERVATION OF SEA FOODS BY RADIO-PASTEURISATION. Kumta, U. S. (Bhabha Atomic Research Centre, Trombay, India). pp 35-7 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

The importance of critical evaluation of processing variables is emphasized; examples of these variables are radiation dose, storage temperature, bacterial, chemical, and sensory indices of spoilage, and chemical pre-treatment for improving product quality. Merits of radiation processing of Bombay duck, shrimp, and pomfrets are discussed, and effects of irradiation on organoleptic properties are considered. Effects of radiation processing on semi-dried and precooked seafoods are discussed. Tests were conducted on polyethylene bags for packaging of fishery products. Studies on biochemical, microbiological, and quality evaluation of stored products were conducted concurrently with processing and storage studies. (H.L.W.)

35968 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: RADIATION PASTEURISATION OF LAMB-MEAT. Sawant, P. L. (Bhabha Atomic Research Centre, Trombay, India). pp 38-9 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Lamb meat was packed in polyethylene bags and γ-irradiated at doses of 0.25 to 0.9 Mrad. Effects of radiation on color and odor at different time intervals and different temperatures were noted. Shelf life studies showed that unirradiated samples stored at 0°C spoiled within 12 days and those stored at 10 to 12°C spoiled within four days; with suitable conditions of radiation and temperature, storage up to 90 days was obtained. (H.L.W.)

35969 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: STATUS OF WHOLESOMENESS STUDIES WITH RADIATION PROCESSED WHEAT GRAIN AND SEA FOODS. Vakil, U. K. (Bhabha Atomic Research Centre, Trombay, India). pp 40-2 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Effects of irradiated wheat in the normal diet of four generations of rats were studied. Physiological studies on growth, reproduction, and longevity, as well as detailed studies on tissue function, hematology, and histology were carried out. No deleterious effects were observed. Short-term studies on rats fed irradiated complete diets were also undertaken. No adverse effects on growth of the animals were observed. A combined process, based on thermal treatment followed by γ radiation, was developed to extend the shelf life of fresh shrimp to 150 days. When irradiated shrimp were fed to young rats, no effects on growth or reproduction were observed. (H.L.W.)

35970 FOOD IRRADIATION TECHNOLOGY. de Proost, Maurice (IAEA, Vienna). pp 43-67 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

The use of ^{60}Co and ^{137}Cs in food irradiation facilities is discussed and ^{60}Co sources are described. In addition to γ radiation from radioisotopes, high energy electrons are used in food preservation research. The production of electrons by high voltage machines is discussed. Irradiation facilities for research purposes are described, and figures are presented to show the structure of a gamma cell and an on-ship irradiator. The importance of pilot plants for working out problems of implementation, determination of effects of radiation sources geometry, and economics of the process for particular food items is pointed out. Tables are presented to show a survey of different pilot plants in operation. Shielding of irradiated plants and safety regulations are considered. The relation of the source strength to the desired absorbed dose and the desired capacity is discussed. Dry and wet types of source storage and source lifting mechanisms are discussed. Methods used in radiation dosimetry and methods of obtaining dose uniformity are discussed. Development of plastic film systems for simple ready made dosimeters is described. (H.L.W.)

35971 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: DESIGN OF ^{60}Co IRRADIATORS (PACKAGE AND THROUGH-FLOW) AT THE FIPLY AND PROBLEMS OF DOSIMETRY IN FOOD IRRADIATION PROCEDURES. Bongirwar, D. R. (Bhabha Atomic Research Centre, Trombay, India). pp 68-9 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

A food package irradiator consisting of large and small source racks was designed for experimental irradiation of fish, fruits, vegetables, and dairy products. A second irradiator was designed for handling grains and other free flowing materials. Dosimetry was carried out using chemical dosimeters: ferrous sulphate and copper sulphate solutions of known concentrations. Standard considerations of dosimetry procedures and dosimeter properties were taken into account for determination of dose distribution and overdose ratios of the radiation sources. (H.L.W.)

35972 RADIATION MICROBIOLOGY, ENTOMOLOGY, AND ENZYMOLOGY. Goresline, Harry E. (International Atomic Energy Agency, Vienna). pp 70-3 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

The role of microorganisms in food spoilage and radiosensitivity of microorganisms are discussed. Advantages of heat treatment combined with radiation are pointed out and attention is called to radiation doses needed to destroy spores of Clostridium botulinum. Economic losses caused by insect pests in cereals and other foods are emphasized, and radiation doses required to destroy various species of insects are discussed. Deterioration of food by the action of enzymes is discussed. These enzymes are very resistant to radiation but are sensitive to heat, so that a combination of heat and radiation seems to be the most feasible method of enzyme control. (H.L.W.)

35973 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: DELAYED RIPENING OF TROPICAL FRUITS (MANGO AND BANANA) BY USE OF GAMMA RAYS. Dharkar, Shri S. D. (Bhabha Atomic Research Centre, Trombay, India). pp 74-7 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Mangoes were placed in sealed bags and irradiated using a gamma cell (AECL: 22000 curies) or the package irradiator (AECL: 100,000 curies). The mangoes were skin-coated with myvacet, an acetylated monoglyceride. The combination of skin-coating and irradiation gave an additional storage life of six days at ambient temperature, making a total of 16 days. Effects of low dose irradiation on ripening delay in four varieties of bananas were studied. Optimum doses for the different varieties varied from 25 to 40 Krad. Biochemical effects of radiation on mangoes and bananas were studied using carbon-14-labeled sodium acetate. Results indicated that radiation caused a depression in metabolism. (H.L.W.)

35974 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: SELECTIVE CONTROL OF SPOILAGE MICROFLORA IN SEA FOODS BY GAMMA-IRRADIATION. Kumta, U. S. (Bhabha Atomic Research Centre, Trombay, India). pp 78-80 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Microorganisms in Bombay duck, shrimp, and pomfrets were identified on the basis of morphological and physiological tests. A number of species of bacteria were found in Bombay duck. Immediately after irradiation the organisms recovered from Bombay duck were Micrococcus, Flavobacterium, and Bacillus. During storage Micrococcus and Achromobacter gained predominance. The relationship between growth and the chemical parameters of freshness was examined using Proteus vulgaris, Aeromonas hydrophila, and Micrococcus luteus as predominant organisms in unirradiated and irradiated fish. (H.L.W.)

35975 ECONOMICS OF FOOD IRRADIATION. Urbain, Walter M. (Michigan State Univ., East Lansing). pp 81-91 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

A factor to be considered in the economics of food irradiation is depreciation of buildings, shielding, and radiation source equipment. The cost of replacing radiation source equipment is dependent on the nature of the radiation source. Other factors to be considered are overhead, labor, maintenance, operating supplies, utilities, taxes and insurance, and third party liability. The importance of considering all costs associated with a radionuclide including the cost of the radionuclide and encapsulation and transportation is emphasized. The total facility cost is the sum of the plant costs and the radiation-source costs. (H.L.W.)

35976 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: COMPOSITIONAL CHANGES AND QUALITY CHARACTERISTICS IN IRRADIATED WHEAT. Vakil, U. K. (Bhabha Atomic Research Centre, Trombay, India). pp 92-4 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

Radiolytic products of starch at different dose levels were characterized by paper chromatographic procedures. Glucose, maltose, and a series of oligosaccharides were discernible with dose levels below 200 krads. Quantitative analysis of the radiolytic products showed that the total reducing sugars increased progressively with dose levels. Radioinduced metabolic disturbance was revealed by impaired seedling growth and reduced amylase and protease activities in germinated wheat. Seed viability was lost up to 50% at 20 Krads and completely at 60 Krads. Pretreatment of seeds with gibberellic acid stimulated the growth at low dose levels but not at high levels. Levels of tyrosine increased about 25% in irradiated wheat. The optical density of isolated lyophylized gluten increased in irradiated samples. Distribution of wheat proteins according to molecular weight was determined by gel filtration. Irradiated wheat was studied with regard to physical properties determining the baking quality of bread. (H.L.W.)

35977 REPORT ON BARC PROGRAMMES IN FOOD IRRADIATION: BIOCHEMICAL STUDIES WITH IRRADIATED SUGAR SOLUTIONS. Aiyar, A. S. (Bhabha Atomic Research Centre, Trombay, India). pp 95-6 of Food Irradiation. Trombay, India, Bhabha Atomic Research Centre, 1969.

From Seminar on Food Irradiation, Trombay, India. See CONF-690117.

A 10% solution of sucrose was subjected to 0.5 Mrad γ radiation. After storage in the frozen condition for two to three weeks, the sucrose was removed by repeated crystallization; the mother liquor contained the toxic fraction. The effects of the toxic fraction on oxidative metabolism of liver mitochondria, liver slices, and perfused liver were studied. Succinate oxidation and phosphorylation were inhibited. Synthesis of lipids, proteins, and DNA were also inhibited. When rats were fed irradiated sucrose solutions no differences in metabolism between control and experimental animals were found. (H.L.W.)

35978 LONGEVITY, RESISTANCE TO DEPRIVATION OF FOOD AND WATER, AND SUSCEPTIBILITY TO MALATHION AND DDT OF ORIENTAL FRUIT FLIES, MELON FLIES, AND MEDITERRANEAN FRUIT FLIES SEXUALLY STERILIZED WITH TEPA OR RADIATION. Keiser, Irving; Schneider, Esther L. (Agricultural Research Services, Honolulu, Hawaii). J. Econ. Entomol., 62: 663-7(June 1969).

In laboratory tests conducted at Honolulu, Hawaii, from 1964 to 1968, oriental fruit flies, Dacus dorsalis Hendel, and Mediterranean fruit flies, Ceratitis capitata (Wiedemann), sexually sterilized with tepa, lived longer than untreated flies of both sexes. Longevity increased with higher dosages of tepa until the chemosterilant acted as a toxicant. Females of these species sterilized by gamma rays lived longer than their untreated counterparts, but male longevity was not increased. The melon fly, D. cucurbitae Coquillett, reacted conversely, in that when it was sterilized by either method, longevity was decreased. Radiation-sterilized or chemosterilized adults of all species withstood food and water deprivation better to varying degrees than their untreated counterparts, when tested at ages associated with 50% natural mortality in populations. They also required more DDT or malathion to achieve comparable mortalities at the LD_{50} and LD_{95} levels than nonsterilized flies. (auth)

35979 NEED FOR IMMEDIATE SUGAR AND ABILITY TO WITHSTAND THIRST BY NEWLY EMERGED ORIENTAL FRUIT FLIES, MELON FLIES, AND MEDITERRANEAN FRUIT FLIES UNTREATED OR SEXUALLY STERILIZED WITH GAMMA RADIATION. Keiser, Irving; Schneider, Esther IL. (Agriculture Research Service, Honolulu, Hawaii). J. Econ. Entomol., 62: 539-40(June 1969).

In tests conducted in the laboratory of the Honolulu Fruit Fly Investigations from 1966–67 with the oriental fruit fly, Dacus dorsalis Hendel; the melon fly, D. cucurbitae Coquillett; and the Mediterranean fruit fly, Ceratitis capitata (Wiedemann), newly emerged flies were placed on 7 different regimens that included sugar, dry hydrolyzed protein, or water, or combinations of these.

These showed that only sugar was critical for survival and that flies could survive several days in cages without water. From these findings, it may be possible to control fruit flies in a large-scale program in which sexually sterilized flies are released by using holding containers that are furnished with sugar cubes instead of the usual cotton material saturated with a solution of sugar and water. Newly emerged sterilized flies survived as well as nonsterilized flies on each deprivation regimen. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 35059, 35365, 35371, 35382, and 36171.

35980 (BNL-50170) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 7, Number 1. (Brookhaven National Lab., Upton, N. Y.). Feb. 1969. 46p. Dep. CFSTI.

A review is presented of high-temperature liquid metal technology that includes information on the physical properties and thermodynamics, fluid dynamics, heat transfer, corrosion and erosion, instrumentation, component development, chemistry, fabrication, and safety. (J.R.D.)

35981 (HW-66628) DEVELOPMENT OF THE NPR FUEL ELEMENT CLOSURE. Correy, Thomas B. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Aug. 29, 1960. Contract AT(45-1)-1350. 27p. Dep. CFSTI.

The NPR fuel element is a tube inside a tube assembly of Zircaloy-2 clad uranium metal. The tubes are produced by a coextrusion process that metallurgically bonds the thin Zircaloy-2 inner and outer cladding to the uranium metal core. The development of the techniques for assembly and sealing of the copper cladding for the extrusion billet assembly and the development of a closure for the fuel tube are discussed in detail. (W.D.M.)

35982 (MLM-1509) VACUUM VAPOR DEPOSITION TECHNIQUES. Nesslage, G. V. (Mound Lab., Miamisburg, Ohio). June 20, 1969. Contract AT(33-1)-Gen-53. 16p. Dep.

Vacuum deposition techniques including vacuum evaporation, ion plating, and sputtering are reviewed. Basic point and directed surface sources are discussed together with basic mathematics from which theoretical calculations of source performance can be derived. Illustrations of the vacuum deposition techniques are presented along with a discussion of each technique. (auth)

35983 (RCN-97(Vol.3)(Pt.2)) THE NERO DEVELOPMENT PROGRAMME. VOLUME III. METALLURGY AND IRRADIATION EXPERIMENTS. (Reactor Centrum Nederland, The Hague). Jan. 1969. 143p. Dep.

Metallurgical and chemical aspects of uranium boride use as a burnable poison in UO_2 reactor fuel are discussed. Data on irradiation behavior of three-rod fuel bundles with poisoned and nonpoisoned fuel are included. A summary of experimental results on out-of-pile corrosion of Zr alloys in flowing water at 340°C is also included along with data and information on welding experimental fuel rods. (J.R.D.)

35984 METHOD OF FORMING NUCLEAR FUEL BODIES. (to EURATOM). French Patent 1,451,699. Filed Oct. 20, 1965.

A method is described for forming compacts containing nuclear fuel particles dispersed in a matrix material. Powder-type matrix forming materials treated with a binder are tumbled with the fuel particles in a drum. The powder grains are contacted as they enter the drum with a mist of a volatile solvent to soften the binder such that the fuel particles acquire an outer coating of the matrix forming material by a snowballing effect. The tumbling is terminated when the coating has achieved the required thickness. The coated particles are then formed into compacts by pressing and heating to set the binder. Preferably the matrix forming material consists of petroleum coke grains coated with phenolformaldehyde resin. (NPO)

35985 ZIRCONIUM DISCUSSION. Gittus, J. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Inst. Metals, 97: 60-3(Feb. 1969).

Aspects of Zircaloy and Zr-Nb alloys important to their use for fuel cladding or pressure tubes in SGHW reactors were discussed. These included creep, radiation growth, yielding phenomena, hydride precipitates, corrosion, and metallurgical problems encountered in processing. (UK)

35986 ISOTOPENANWENDUNGEN IN DER METALLVERARBEITENDEN INDUSTRIE. (Isotope Applications in the Metal-Working Industry). Bern, Schweizerische Vereinigung fuer Atomenergie, 1968. 17p.

The methods for isotope utilization in metal processing are described. Examples are given of gammagraphy, continuous density control, filling control, measurement of displacement and momentum, moisture control, and studies of physical-chemical processes. The economic significance of isotope methods is evaluated. (J.S.R.)

35987 ISOTOPE APPLICATIONS IN HEAVY METALLURGY. Com. Naz. Energ. Nucl., Notiz., 15: No. 3, 83-5(Mar. 1969). (In Italian).

Aspects of isotope uses in heavy metallurgy are summarized. (J.S.R.)

35988 EFFECT OF CRACKS ON CREEP RATE. Weertman, J. (Los Alamos Scientific Lab., N. Mex.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 502-11(June 1969).

An analysis is made of the displacement velocity across a crack in a material undergoing high-temperature creep deformation. The analysis is concerned primarily with material whose creep rate depends linearly on stress. Both isotropic and anisotropic material are considered. Estimates are made of the change in creep rate produced by the presence of a high density of cracks. It is concluded that a high crack density increases the tensile creep rate (when the tensile axis is normal to the crack planes) much more profoundly than it does the creep rate in shear. This conclusion is in agreement with the results obtained by Zukas and Green from high-temperature creep measurements on highly-oriented polycrystalline graphite. (auth)

Corrosion and Erosion

Refer also to abstract 36101.

35989 (GEAP-5445) POTENTIOSTATIC INVESTIGATION OF TYPE-304 STAINLESS STEEL IN DISTILLED WATER AT 300°C. de Hollander, W. R. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). June 1967. Contract AT(04-3)-189. 22p. (EURAEC-2109). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Equipment was designed and operated to obtain potentiostatic data on austenitic stainless steel fuel rod cladding samples at temperatures of 200, 250, and 300°C. Although characteristic curves were obtained, they are not typical of active-passive transition-type curves. Potentiostatic studies of the type employed in this study on stainless steel in 300°C distilled water were of no assistance in delineating stress-corrosion mechanisms. It is felt that potentiostatic studies of different types could be useful, and this is discussed in the text. Data obtained on stainless steel were marked by an unstable potential behavior. Corrosion apparently is not fast enough to cause a protective film to form adequately. The samples, after extensive testing, were not cracked but were extensively pitted. This is postulated to be the reason that the potential was fluctuating. (auth)

35990 (IITRI-578-P-29-37) RESEARCH ON ZIRCALOY BRAZE ALLOY DEVELOPMENT. Final Report, April 1, 1966-June 30, 1969. (IIT Research Inst., Chicago, Ill.). June 30, 1969. Contract AT(11-1)-578. 122p. (EURAEC-2113). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The development of braze alloys for use in a water-cooled reactor environment has been undertaken. A dynamic chemical shim-resistant alloy for brazing Zircaloy-2 and Zircaloy-4 material was required. Over 150 candidate alloys were investigated for brazing capability and corrosion resistance. A number of braze alloys have been developed that are considered suitable for the application with moderate corrosion rates and good joint mechanical strength. These alloys are Zr-50Ag, Zr-29Mn, and Zr-24Sn. Seven other alloys from the original selection proved to have good corrosion resistance but inferior mechanical properties. (auth)

35991 (IN-1289) SEVERAL DETERIORATION MECHANISMS OF THE MATERIALS TESTING REACTOR BERYLLIUM. Neill, D. T.; Morris, R. H. (Idaho Nuclear Corp., Idaho Falls). May 1969. Contract AT(10-1)-1230. 55p. Dep. CFSTI.

Several possible mechanisms for the damage to the MTR beryllium reflector are examined. Detailed thermal and stress analyses are presented to support the selection of a combination of radiation growth and external restraint as the primary failure mechanism. Several suggestions are made to eliminate potential hazards to the replacement beryllium reflector. (auth)

35992 (KFK-879) INNER OXIDATION AS A CORROSION PHENOMENA OF LIQUID SODIUM WITH SMALL SODIUM OXIDE CONTENT. Borgstedt, H. U.; Frees, G. (Kernforschungszen-

trum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung. Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Dec. 1968. 17p. (In German). (EUR-4159). Dep.

In the corrosion of titanium-containing vanadium alloys in liquid sodium with oxide concentration below 10 ppM in the temperature range 500 to 600°C, embrittlement phenomena in the metal phase were observed as a result of the penetration of oxygen. Thermochemical hypotheses were given for the internal oxidation of vanadium–titanium alloys in flowing sodium. The penetration of the oxygen into the alloy is consistent with the phenomenon of internal oxidation. Ideas for future alloy development were obtained from the experimental data. (tr-auth)

35993 (ORNL-TM-2563) LOW-TEMPERATURE DUCTILITY AND HYDROGEN EMBRITTLEMENT OF URANIUM. A Literature Review. Inouye, H.; Schaffhauser, A. C. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 41p. Dep. CFSTI.

The ductile-to-brittle transition temperature of uranium, which ranges between 100 and –50°C, is influenced by the grain size, strain rate, and the grain structure. The ductility of uranium at room temperature depends upon the heat treatment, fabrication procedures, and the testing conditions. Aluminum, silicon, and carbon impurities in concentrations below 1000 ppM impair the ductility. A literature review of the hydrogen embrittlement of uranium was made. Threshold concentrations between 0.2 and 0.5 ppM H present as $\beta-UH_3$ are the probable causes of the severe impairment of the ductility at room temperature. The morphology of UH_3 and microcracks associated with this phase also influence the degree of embrittlement. The hydrogen in heat-treated uranium is derived from the reaction of uranium with water vapor in the annealing media. (auth)

35994 (WAPD-Trans-118) INORGANIC CHEMISTRY: MICROGRAPHIC STRUCTURE OF OXIDE LAYERS FORMED DURING THE OXIDATION OF MASSIVE ZIRCONIUM. Debuigne, Jean; Lehr, Pierre. Translated for Bettis Atomic Power Lab., West Mifflin, Pa.), from Compt. Rend., Ser. C, 266: 903-5(1968). 5p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 28739. (auth)

35995 METHOD OF INHIBITING THE CORROSION OF GRAPHITE IN A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,461,586. Filed Oct. 26, 1965.

A method of inhibiting the corrosion of graphite in graphite-moderated CO_2-cooled nuclear reactors is described. The improvement consists in adding to the CO_2 at least one organometallic compound, such as $Pb(CH_3)_4$, $Pb(C_2H_5)_4$, or $Al(CH_3)_3$ in a quantity of about 0.2 wt %. (NPO)

35996 FLAW GROWTH IN Ti-6Al-4V IN FREON ENVIRONMENTS. Raymond, L.; Usell, R. J. (Aerospace Corp., El Segundo, Calif.). Corrosion, 25: 251-9(June 1969).

The general and stress corrosion behavior of Ti-6Al-4V alloy in Freon environments were investigated. Intentionally flawed specimens were examined to determine the ability of the metal to sustain defects on exposure to stress and environment. Freon TF and Freon MF were used as base environments for the study. In addition to testing with commercially pure Freons, chlorine-doped Freons were used. Two thicknesses of solution-treated and aged Ti-6Al-4V alloy were used. The crack-bearing properties of a metal in the presence of an environment is based on the framework of fracture mechanics. It is indicated that the primary function of stress intensity in the Ti-6Al-4V/Freon MF interaction is the exposure of fresh titanium surfaces to the environment through plastic deformation at the crack tip. (auth)

35997 MOLYBDENUM COATING DEVELOPED FOR HIGH TEMPERATURE APPLICATION. Corrosion, 25: 284(June 1969).

The development of a silicide coating process has made possible the use of molybdenum parts for high temperature applications. Siliciding is used to apply a thin, pore-free layer of $MoSi_2$ on the surface. The temperatures at which the process operates, around 1250°F, are below the recrystallization temperature of molybdenum. The molybdenum substrate does not embrittle as it does in the higher temperature (1800 to 2300°F) gaseous process. Furthermore, the silicide coatings are moderately flexible, free of the pest phenomenon at low temperatures (950 to 1300°F), and are considered outstanding in their performance at high temperatures. (J.R.D.)

35998 CORROSION OF REACTOR MATERIALS UNDER IRRADIATION. Nomura, Suso (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 11: 353-61(1969). (In Japanese).

Corrosion of reactor materials under irradiation is reviewed and discussed. Included are discussions of radiation damage in metals, radiation damage in oxide films, and radiation effects on corrosion environment. Radiation damage on metal surface stimulates the dissolution of the metal into aqueous solution and reduces its electrode potential. Results of tests indicate that high temperature aqueous corrosion of Zr and Zy-2 is accelerated by damage in the metal substrata rather than on the surface oxide film. The effects on corrosion brought by damage in the oxide film is explained in terms of increases in density, in electronic conductivity, in diffusivity, and in surface chemical reactivity. Radiolysis of the aqueous environment also influences the corrosion of metal through changes in the electrochemical properties of solution and of metal electrode. (auth)

35999 USE OF INTERNAL DAMPING MEASUREMENTS IN THE STUDY OF ENVIRONMENTAL CRACKING. Thiruvengadam, A.; Gunasekaran, M.; Preiser, H. S. (Hydronautics, Inc., Laurel, Md.). Corrosion, 25: 243-50(June 1969).

Tests on 2024-T4 aluminum, 2024-T3 aluminum, Ti-6Al-4V and Ti-8Al-1Mo-1V are reported wherein considerable changes in the internal damping of these materials were observed following their exposure in a stressed state to environments in which they are known to be susceptible to cracking. (Corroborative tests on 1020 mild steel and electrolytic copper stressed and exposed to a corroding environment of air saturated synthetic sea water produced no changes in internal damping. These materials are normally immune to stress corrosion cracking under the above conditions of exposure.) Theoretical ideas with supporting experimental evidence are presented in an attempt to arrive at a basic understanding of the phenomenon of environmental cracking by correlating the laws of diffusional mechanics of materials to those pertaining to changes in their internal damping. (auth)

36000 STUDY OF CORROSION DAMAGE BY MEANS OF β-BACKSCATTERING. Krivan, V. (Slovakian Technical School, Bratislava). Werkst. Korros., 19: 1021-5(1968). (In German).

Corrosion of metal plates was studied by measurement of backscattering of β particles from ^{89}Sr, ^{204}Tl, ^{85}Kr, ^{185}W, and ^{147}Pm. Standardizations of the tests were carried out by layering of known amounts of corrosion products on test plates, or by direct corrosion of the metal and evaluation of the corrosion layer thickness by other methods. The counting rates of the backscattered β particles increased markedly with the at. number of the target metal. Count rates of β backscatter decreased markedly with the wt/unit area of the corrosion plates for ^{147}Pm, ^{185}W, ^{204}Tl, and ^{89}Sr. The effective ranges over which these radioisotopes were usable were from 0 to 8, 16, 30, and 65 mg/cm^2, respectively. The sensitivity of the method was directly related to the ratio between the alteration of the β-backscatterer intensity and the corrosion layer thickness. This relation depended largely on the energy of the β irradiation used. Results of the corrosion tests indicated that the β-backscatter method agreed closely with the results obtained by weighing methods. (BBB)

36001 CORROSION BEHAVIOR OF URANIUM AND OTHER TRANSITION METALS IN RELATION TO THE PROPERTIES OF THE SURFACE OXIDE FILMS. Elsayed, A. A. London, London Univ., 1969. 190p.

Thesis.

The effect of hydrogen on the corrosion behaviour of some uranium-rich alloys and titanium was studied. The impedance and crystal structure of the corrosion films grown on these metals and on vanadium were investigated as a function of the formation potential. Optical absorption and ellipsometric techniques were used for the continuous measurement of film thickness during corrosion, and an impedance bridge was used in measuring the electrode capacitance and conductance. The crystal structure of the corrosion films was examined by electron diffraction. The results emphasize the role of the corrosion product hydrogen in affecting rates of corrosion of these metals by changing the electronic conductivity of the protective, semiconducting oxide film. High values of capacitance and conductance, observed at certain potentials, are considered to arise from a reversible reaction in the oxide involving a valency change of the metal ions. Electron diffraction revealed that the structure of these corrosion films changes with their formation potential. (auth) (UK)

36002 METHOD OF PROTECTING MAGNESIUM OR MAGNESIUM ALLOYS AGAINST CHEMICAL ATTACK. (to Commissariat a l'Energie Atomique). French Patent 1,408,882. Filed July 9, 1964.

A method of protecting components of a nuclear reactor cooled

by a gas under pressure, which are composed of Mg or weakly alloyed Mg, against chemical attack is described. A nitriding gas is circulated in the cooling gas circuit while the components are maintained at a sufficiently high temperature for a sufficiently long time to form a superficial nitride layer on the components. The temperature should be above 550°C and below the melting point of the Mg or the Mg-alloy. The coolant may be CO_2 and the nitriding gas N_2 or NH_3, the latter having a pressure or a partial pressure of 1 bar at 550°C and at least 12 bars at 590°C. (NPO)

36003 PROCESS FOR THE PROTECTION OF MAGNESIUM AND ITS ALLOYS AGAINST CORROSION BY ORGANIC LIQUIDS. (to EURATOM). French Patent 1,464,544. Filed Jan. 20, 1966.

A process is described for the protection of Mg and Mg-alloys against corrosion by organic liquids which are used as coolant and/or moderator in nuclear reactors. The process comprises adding ammonia and carbon dioxide to the organic liquids in a total quantity of 0.001 to 1 wt.%. In practice chemical compounds are added which are decomposed at the operating temperature of the reactor so as to form free NH_3 and CO_2. (NPO)

36004 INFLUENCE OF LOW VAPOR PRESSURE OF WATER ON THE OXIDATION AND HYDRIDATION OF ZIRCONIUM–COPPER ALLOYS IN CARBON DIOXIDE AT HIGH TEMPERATURES. Darras, Raymond; Baque, Pierre; Sannier, Jacques (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C, 268: 1913-16(June 2, 1969). (In French).

The presence of water vapor in carbon dioxide increased appreciably the speed of oxidation of copper–zirconium alloys. However, the penetration of hydrogen remained small in these alloys, contrary to the case of unalloyed zirconium. (tr-auth)

36005 PROCEEDINGS OF CONFERENCE ON FUNDAMENTAL ASPECTS OF STRESS CORROSION CRACKING, COLUMBUS, OHIO, SEPTEMBER 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969. 736p. (CONF-670985).

A total of 50 papers were presented at the conference. A separate abstract was prepared for each of eight papers. Papers for which no abstracts were prepared are concerned with general aspects of corrosion cracking, homogeneous noble metal alloys, homogeneous Fe–Cr–Ni alloys, high-strength steels, and Al alloys. (J.R.D.)

For abstracts of individual papers see: 36006–36013.

36006 STRESS CORROSION CRACKING OF TITANIUM AND ITS ALLOYS. Boyd, W. K. (Battelle Memorial Inst., Columbus, Ohio). pp 593-602 of Proceedings of Conference on Fundamental Aspects of Stress Corrosion Cracking, Columbus, Ohio, September 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969.

See CONF-670985.

The present technology related to corrosion cracking of Ti is discussed. Included is a review of general features associated with aggressive environments which have not been studied in detail. Information is also included on metallurgical and environmental factors which appear to play a role in cracking, particularly in exposure of Ti and its alloys to hot salt, N_2O_4, methanol, and water. (J.R.D.)

36007 ELECTROCHEMICAL ASPECTS OF TITANIUM STRESS CORROSION CRACKING. Beck, T. R. (Boeing Scientific Research Labs., Seattle). pp 605-19 of Proceedings of Conference on Fundamental Aspects of Stress Corrosion Cracking, Columbus, Ohio, September 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969.

See CONF-670985.

Notched tensile specimens of Ti: 8% Al–1% Mo–1% V alloy were tested in air and in various electrolyte solutions under potentiostatic conditions. It was found that stress corrosion cracking of this alloy occurred only in the presence of three anions–chloride, bromide and iodide. The velocity of crack propagation was linearly related to the applied potential with an intercept at −900 mV versus saturated calomel electrode. The same line fits the data for chloride, bromide, and iodide solutions indicating that the same electrochemical mechanism controls the stress corrosion cracking velocity. A quantitative model for the electrochemical kinetic and mass transport processes in a propagating stress corrosion crack has been developed. Kinetic data obtained for oxidation of and hydrogen ion reduction on newly generated Ti: 8-1-1 surface were used in the model. Results of the calculations compared with experimental data for stress corrosion cracking of Ti: 8-1-1 alloy indicate that there is a current of halide ions to the tip corresponding to the formation of a monolayer of adsorbed halide ions or titanium halide. The mechanism of propagation appears to be either a lowering of surface energy or electrochemical reaction at the crack tip with velocity controlled by mass transport. (auth)

36008 METALLURGICAL ASPECTS OF THE STRESS CORROSION CRACKING OF TITANIUM ALLOYS. Blackburn, M. J.; Williams, J. C. (Boeing Co., Seattle). pp 620-37 of Proceedings of Conference on Fundamental Aspects of Stress Corrosion Cracking, Columbus, Ohio, September 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969.

See CONF-670985.

The metallurgical and mechanical factors which interact with the electrochemistry of Ti alloys corrosion cracking are considered. The number of variables makes generalization difficult unless these are qualified by specification of the test conditions. It is shown that failure of α-phase in Ti: Al alloys and in the commercial alloy Ti: 8Al: 1Mo: 1V under stress corrosion cracking (SCC) condition occurs by cleavage on the $\{10\bar{1}8\}$–$\{10\bar{1}7\}$ plane of the hexagonal phase. The general phase structure of these alloys is described and it is shown that the $\alpha \rightarrow \alpha + \alpha_2$ (Ti_3Al) transformation is of considerable importance in determining susceptibility. In the commercial alloy, presence of the β-phase and the martensitic phases reduce susceptibility. Results on the binary Ti: Al alloys indicate that the onset of susceptibility to SCC occurs at 4 to 5% aluminum which correlates with a change from homogeneous to planar dislocation arrangements. The influence of stress on the nucleation and propagation of a crack has been analyzed for precracked specimens, using the methods of linear elastic mechanics. From these results several factors which influence the nucleation stage are discussed. It is proposed that for a propagating crack, there are two components of fracture, i.e., electrochemical and mechanical. At low α-phase strength levels or aluminum contents the electrochemical component predominates while at higher strength levels or aluminum content the mechanical component increases. Some qualitative correlations are made between mechanical properties, deformation structures, fracture mode, and susceptibility to SCC. (auth)

36009 METALLOGRAPHIC STUDIES OF THE STRESS CORROSION CRACKING OF TITANIUM ALLOYS IN AQUEOUS CHLORIDE SOLUTIONS. Sanderson, G.; Powell, D. T.; Scully, J. C. (Univ. of Leeds, Eng.). pp 638-49 of Proceedings of Conference on Fundamental Aspects of Stress Corrosion Cracking, Columbus, Ohio, September 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969.

See CONF-670985.

Ti, Ti–5Al–2.5Sn, Ti–6Al–4V and a series of binary Ti–Al and Ti–Sn alloys have been studied in $MgCl_2$ solutions boiling at 154°C. The first three materials have also been studied in 3% NaCl solution at room temperature. At 154°C pitting occurs and under stress all the alloys suffer intergranular cracking and fissuring. Surface hydrides change the predominant mode to transgranular in the richer alloys. The mechanism is thought to be the result of slow dissolution. In 3% NaCl solutions the cracking takes place as an interrupted cleavage process as revealed by scanning electron microscopy. This occurs as a result of hydrogen pickup on freshly created metal surfaces at the tip of the propagating crack where plastic deformation aids the hydride formation mechanism which initiates the cleavage. (auth)

36010 ROLE OF MOISTURE AND HYDROGEN IN HOT-SALT CRACKING OF TITANIUM ALLOYS. Rideout, S. P.; Ondrejcin, R. S.; Louthan, M. R. Jr.; Rawl, D. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). pp 650-61 of Proceedings of Conference on Fundamental Aspects of Stress Corrosion Cracking, Columbus, Ohio, September 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969.

See CONF-670985.

The role of moisture and hydrogen in the stress corrosion cracking of Ti–8Al–1Mo–1V exposed to hot chloride salts was investigated. The adsorption and retention of moisture during the application of salt deposits and subsequent heating, and the extent of HCl and hydrogen generation during corrosion were studied using radiotracer techniques and mass spectrographic analyses of volatile corrosion products. Hot-stage microscopy and cinematography were used to study crack initiation and propagation, and the characteristics of fracture surfaces were examined by electron fractography. The effects of NaCl were compared to those of $SnCl_2 \cdot 2H_2O$, which not only retains much more moisture but also has a much lower melting point than NaCl. These studies revealed an obvious association between the occurrence of crack-

ing and the amounts of HCl and hydrogen generated during hot-salt corrosion. This, combined with results of supplementary experiments using sodium iodide and bromide, indicates that hydrogen, rather than the halide, plays the key role in the cracking process. The observations are consistent with a stress-sorption mechanism for cracking, in which corrosion-produced nascent hydrogen is proposed to be the sorbed species responsible for cracking. (auth)

36011 STUDIES OF HOT SALT CRACKING OF THE TITANIUM 8 PERCENT Al–1 PERCENT Mo–1 PERCENT V ALLOYS. Logan, Hugh L. (National Bureau of Standards, Washington, D. C.). pp 662-72 of Proceedings of Conference on Fundamental Aspects of Stress Corrosion Cracking, Columbus, Ohio, September 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969.
See CONF-670985.

Two approaches to the problem of hot salt cracking of the titanium alloy are reported. In the first of these the susceptibility of the alloy to cracking in contact with a number of chlorides was studied. Only NaCl, LiCl, and a molten eutectic mixture of LiCl and KCl were found to severely crack stressed specimens exposed in air at 800°F. In the second phase of the program the effects of environments on the alloy in contact with NaCl were investigated. Data indicate that the oxide or series of oxides formed on the alloy surface were important in determining whether specimens developed stress corrosion cracks. Data also indicate that little chlorine was produced in the corrosion reaction. (auth)

36012 SUBCRITICAL CRACK PROPAGATION IN Ti–8Al–1Mo–1V ALLOY IN ORGANIC ENVIRONMENTS, SALT WATER, AND INERT ENVIRONMENTS. Sandoz, George (Naval Research Lab., Washington, D. C.). pp 684-90 of Proceedings of Conference on Fundamental Aspects of Stress Corrosion Cracking, Columbus, Ohio, September 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969.
See CONF-670985.

A comparative study of the stress corrosion susceptibility of a Ti–8Al–1Mo–1V alloy in salt water, alcohols, and alkanes was made utilizing precracked specimens and cantilever loading. All of these environments were found to cause crack propagation at values of stress intensity less than required to produce fracture in dry air. In dry air, however, the stress intensity required to produce crack growth and fracture was found to be time and section size dependent and lower than K_{Ic}. The long-chain alcohols and the alkanes appear to cause crack propagation at about the same stress intensity level. Similarly, salt water, methanol, and ethylene glycol are of a class, but produce crack propagation at lower levels of stress intensity. The environments studied, except for dry air, appear to cause crack propagation at about the same stress intensity level whether the specimens meet the requirements for plane strain conditions or not. (auth)

36013 STUDY OF STRESS CORROSION CRACKING OF COMMERCIAL TITANIUM ALLOYS. Adams, R. E.; von Tiesenhausen, E. (Titanium Metals Corp. of America, New York). pp 691-700 of Proceedings of Conference on Fundamental Aspects of Stress Corrosion Cracking, Columbus, Ohio, September 11–15, 1967. Staehle, R. W.; Forty, A. J.; van Rooyen, D. (eds.). Houston, Tex., National Association of Corrosion Engineers, 1969.
See CONF-670985.

A study aimed at determination of singular factors adversely affecting stress corrosion resistance of Ti alloys in salt water and hot salt environments is described. Single phase alloys were sought which exhibited resistance and susceptibility to stress corrosion. The alpha alloy Ti–5Al–2.5Sn and the beta alloy Ti–13V–11Cr–3Al are susceptible to salt water cracking while the alpha alloy Ti–10Zr–4Sn and the beta alloy Ti–11Mo–5Zr–5Sn are resistant. In addition, studies were made of the alpha-beta alloy Ti–8Al–1Mo–1V, which is susceptible to salt water and hot salt cracking. The susceptible single phase alloys and the Ti–8Al–1Mo–1V alloy have been studied by means of optical and electron metallography and transmission electron microscopy. Degree of salt water fracture susceptibility of Ti–8Al–1Mo–1V alloy was related to its fine microstructure. Optical metallography of Ti–8Al–1Mo–1V alloy indicated that hot salt cracks generally propagate along alpha-beta phase boundaries. Optical metallography of Ti–13V–11Cr–3Al revealed that salt water cracks propagate transgranularly while the cracks in Ti–5Al–2.5Sn seem mainly intergranular. Planar dislocation arrays have been observed in both the Ti–13V–11Cr–3Al alloy and the Ti–5Al–2.5Sn alloy but are more predominant in the former. Studies of binary alloy systems have shown that concentrations of interstitial elements far greater than normally found in commercial alloys do not promote susceptibility to stress corrosion. Of the many substitutional alloying elements studied, Hf, Mo, Nb, Re, Ta, and Zr do not have adverse effects on hot salt cracking susceptibility of binary alloys unless present in exceptionally high concentrations. Data gathered on binary alloys indicate alloy additions resulting in a change of β lattice parameter in excess of 0.5% contribute to stress corrosion susceptibility. (auth)

36014 CORROSION-PRODUCT STUDY BY SCANNING ELECTRON MICROSCOPY. Daniel, J. Leland; Kabele, Thomas J. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 83-4(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36015 STOCHASTICS OF COOLANT CRUD. Bartlett, John W. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 84-5(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36016 EFFECTS OF THE FLUID REGIME ON THE DEPOSITION OF IRON CORROSION PRODUCTS. Kabele, Thomas J.; Bartlett, John W. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 83(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36017 SAMPLES AND SAMPLING METHODS FOR CORROSION PRODUCTS IN WATER-COOLED NUCLEAR SYSTEMS. Rae, H. K. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 12: 70-1(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36018 COMPATIBILITY OF VANADIUM ALLOYS WITH HIGH-TEMPERATURE SODIUM. Whitlow, G. A.; Schrock, S. L.; Hornak, R. J.; Bishop, E. C. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 121(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36019 CORROSION AND DEPOSITION OF IRRADIATED STAINLESS STEEL IN SODIUM. Brehm, W. F.; Kovacevich, E. A.; Shannon, D. W. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 121-2(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36020 REACTIVITY OF HYDROGEN WITH Ti–6Al–4V UNDER FATIGUE CYCLING AT AMBIENT AND CRYOGENIC TEMPERATURES. Pittinato, G. F. (McDonnell Douglas Corp., Santa Monica, Calif.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 410-17(June 1969).

The reactivity of Ti-6Al-4V with hydrogen was determined in the temperature range of 75 to −423°F by conducting crack propagation tests using fatigue cycling. It was shown that high-purity hydrogen gas reacts with a clean surface of Ti-6Al-4V in the temperature range of 75 to −100°F. The reaction results in hydrogen being absorbed at the crack interface, an acceleration of the crack propagation rate, and a change in the fracture mode. The fracture surfaces of the fatigue samples tested in hydrogen contained deep cracks at fatigue striations and extensive secondary cracking. There were no indications of a detrimental hydrogen reaction occurring in the temperature range of −100 to −423°F. (auth)

36021 RELATIONSHIP BETWEEN COMPOSITION, MICROSTRUCTURE, AND STRESS CORROSION CRACKING (IN SALT SOLUTION) IN TITANIUM ALLOYS. Curtis, R. E. (Boeing Co., Renton, Wash.); Boyer, R. R.; Williams, J. C. ASM (Amer. Soc. Metals), Trans. Quart., 62: 457-69(June 1969).

Four alpha titanium alloys and 9 $\alpha + \beta$ titanium alloys have been characterized to relate phase composition and associated microstructure to stress corrosion cracking (SCC) in 3.5% aqueous sodium chloride solution. Of these alloys, only a low-interstitial, commercially pure alpha alloy (Ti-50A) was immune to SCC under the conditions of these tests. Addition of oxygen, aluminum, or aluminum and tin restricted slip in the alpha phase and promoted stress corrosion susceptibility. Formation of ordered domains of $Ti_3(Al,Sn)$ further restricted slip and increased susceptibility. Stress corrosion resistance was improved by thermo-mechanical treatments that reduced alpha grain size or increased dislocation density. Alpha phase susceptibility is qualitatively related to the intensity of the stress field surrounding a dislocation pileup. Alloying with molybdenum or vanadium or both increased strength and often improved stress corrosion resistance. This is attributed to stabilization of the ductile beta phase. However, precipitation of a fine dispersion of alpha or omega in beta caused embrittlement and reduced the stress corrosion threshold. Intermetallic compound formation in alloys containing copper or silicon similarly promoted susceptibility. Thermo-mechanical processing of Ti-

4Al-4Mo-2Sn-0.5Si limited the embrittlement, probably by refining Ti_5Si_3 particles in the beta phase. (auth)

36022 MICROSTRUCTURES AND KINETICS OF INTERNALLY OXIDIZED DILUTE ZIRCONIUM–YTTRIUM ALLOYS. Wilkins, B. J. S.; Chater, J. (Atomic Energy of Canada Ltd., Manitoba, Can.). J. Nucl. Mater., 31: 288-99(July 1969).

Yttria dispersions produced in alpha and beta zirconium by internal oxidation are described. They consist of particles from 0.2 to >5 μm in diameter which are too large to produce dispersion strengthening. The composition of alloys studied ranged from 0.05 to 1.5 wt % yttrium and were oxidized at temperatures between 800 and 1600°C. The observed oxidation kinetics and distribution of yttrium in solution after oxidation are explained in terms of the diffusion processes involved and the variation with composition of Y_2O_3 solubility in zirconium. Terminal solid solubility curves for Y_2O_3 in beta zirconium have been calculated from kinetic expressions derived for the process. (auth)

36023 WEAR AND FRICTION OF FIBER-METAL MOLYBDENUM BODIES IMPREGNATED WITH MOLYBDENUM DISULFIDE. Bhattacharyya, S.; Schwartzbart, H. (IIT Research Inst., Chicago). ASM (Amer. Soc. Metals), Trans. Quart., 62: 318-23 (June 1969).

A feasibility study has clearly indicated the suitability of MoS_2-coated fiber-metal compacts in effecting a low coefficient of friction and a high coating-endurance life. Better results were obtained when the sliding surface was either molybdenum metal or TZM alloy instead of 440°C stainless steel. Temperatures up to 600°F did not produce any detectable oxide. Spray coating of the as-compacted surface after pressure impregnation appears to hold promise for a long coating-endurance life. (auth)

36024 COMPATIBILITY OF SOME HIGH-TEMPERATURE THERMOCOUPLE MATERIALS IN A CARBON–HYDROGEN ENVIRONMENT. Fries, R. J.; Cummings, J. E.; Hoffman, C. G.; Daily, S. A. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 32: 171-3(Aug. 1969).

Results of studies conducted to determine the maximum useful temperature for several oxide insulator-refractory metal pairs for high temperature thermocouples are presented. It was found that the stability of the oxides increases from BeO to ThO_2 to HfO_2 and the stability of the metals increases from molybdenum to W-26 wt % Re to tungsten to tantalum. Thus, the tantalum-HfO_2 pair is the most stable with no reaction observed at 2650°C. These are not the orders of stability that would be predicted on the basis of the available thermodynamic data. The free energies of formation (ΔG_f) of the various solid oxides at 2500°K are (all in kcal/mole oxygen): ThO_2, −188; BeO, −168; HfO_2, −160; WO_2, −39; Ta_2O_5, −99; and MoO_2, −40. On this basis, tantalum should be the least stable capsule material by a substantial margin. Also, the insulator stabilities would be expected to increase in the order HfO_2, BeO, and ThO_2. (J.R.D.)

Preparation and Fabrication

Refer also to abstracts 35121, 35386, 35761, 37626, and 37837.

36025 (BNWL–1113) THIN FILM RARE-EARTH POLONIDES. Jarrett, J. H.; Brite, D. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

The results of an investigation of the reaction of polonium-210 vapor with rare-earth films are reported. Handling techniques and reaction conditions required for preparation of thin films of rare-earth polonides with good integrity and optimum thermal stability above 1000°C are described. Rare-earth polonide compounds having the greatest thermal stability were obtained by reaction at 1200°C and removal of excess polonium by distillation at 1200°C. (auth)

36026 (CEA-CONF-1241) NICKEL COATING BY DECOMPOSITION OF NICKEL CARBONYL ON PLUTONIUM ALLOYS. Auvity, J.; Beaumont, J. C.; Fain, E.; de Fouchier, A.; Lecocq, J. C. (Commissariat a l'Energie Atomique, Montrouge (France)); Rabault, J. J. (Societe d'Etudes et d'Applications Vide Optique Mecanique, Argenteuil (France)). [1968]. 15p. (In French). (CONF-681048-1). Dep.

From International Conference on Applications of Vacuum Science and Techniques to Coating and Surface Finishing, Dijon, France.

Coating of plutonium alloys with Ni by the endothermal decomposition of nickel carbonyl by the Owen process was studied. The deposition conditions were described. The particular case of Pu alloys was considered. The results obtained show that the structure of the coatings depends on the decomposition temperature. The method was applied to the coating of Pu alloys of relatively large dimensions. (J.S.R.)

36027 (CONF-680625-5) TUBE DEVELOPMENT FOR NUCLEAR PLANT. Hockly, D. K. A. (Extended Surface Tube Co. Ltd. (England)). [1968]. 16p. Dep.

From BNX/BNF Nuclear Power Meeting, Copenhagen, Denmark.

Manufacturing techniques developed for the production of integral and welded fin tubes are described in detail. The integral fins are produced by a rolling process which radially extrudes the fin from a high-quality thick-walled plain tube. The welded fin tube is made by spirally winding and welding a strip on to a tube by methods which give a clean, strong weld at least as wide as the strip thickness without damaging the tube wall. Each type is evaluated and the testing, inspection, and quality control described. Developments in the use of finned tubing for steam/steam reheaters are discussed. (UK)

36028 (EURAEC–2093) STAINLESS PLATING OF HEAVY-GAUGE STEELS. Final Report. (Neratoom, N. V., The Hague (Netherlands). Thent Rijksuniversiteit (Belgium). Soudometal, S. A., Brussels (Belgium)). [1968]. Contract 008-63-12-TEEB-RD. 74p. (EUR–4013). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

The superiority of the strip process with regards to other plating processes was confirmed. The simplicity of the equipment makes it useful and safe. The depositing speeds are high and there are but very few risks of fault and crack formations in the deposits. It is possible to plate parts having a complicated profile. Among the stainless steel compositions which can be deposited the types ASTM 308 L, 316 L, 316 L with low ferrite content, 347, and 318 may be cited. This enumeration is by no means limiting. By means of this process it is also possible to deposit, among others, pure nickel, various nickel alloys, and cupro-nickels. (J.R.D.)

36029 (RFP–1315) ROLLING TEXTURE OF SOME PLUTONIUM–GALLIUM ALLOYS. Schindler, Joseph E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). May 12, 1969. Contract AT(29-1)-1106. 7p. Dep. CFSTI.

The rolling textures of Pu-0.75 wt % Ga and Pu-1.0 wt % Ga alloys were studied as a function of rolling reduction through the use of pole figures. The samples were cold-rolled to 70%, 80%, 90%, or 95% reduction. The texture of the alloys was found to be very close to that of cold-rolled copper at high reductions. (auth)

36030 (SC-DR-69-185) METHOD OF PRODUCING FOILS OF MULBERRY FOR TRANSMISSION ELECTRON MICROSCOPY. Greulich, Frederick A. (Sandia Labs., Albuquerque, N. Mex.). June 1969. 16p. Dep. CFSTI.

Results of a study to determine methods of producing foils of U−7½% Nb−2½% Zr alloy to be used for transmission electron microscopy are presented. Suitable foils were produced by spark cutting and spark planing followed by final thinning in a dual jet thinner using a solution of 6% $HClO_4$ in methanol. A chemical etch-polishing solution consisting of 35 ml HCl, 25 ml H_2O, 5 ml HNO_3 and 1 ml (25 drops) HF has also been developed for intermediate thinning to replace spark planing for faster preparation of gamma phase material. (auth)

36031 (UCSD–34-P-162-11) NEW MATERIALS BY LOW-TEMPERATURE CONDENSATION. Progress Report. Luo, Huey-Lin (California Univ., La Jolla, San Diego). Feb. 15, 1969. Contract AT(11-1)-34. 25p. Dep. CFSTI.

Activities in a program devoted to preparation and measurements of $Nb_3(Al_{0.75}Ge_{0.25})$ intermetallic compounds are summarized. Efforts were devoted to determining the sputtering yield of pure Nb and preparation of Nb−Al alloys by sputtering. Data on Nb−Al films produced by sputtering are included. (J.R.D.)

36032 (ZJE–37) STEEL PRESSURE VESSEL FOR NUCLEAR REACTOR. Stepanek, Stanislav (Skoda Works, Pilsen (Czechoslovakia)). July 1968. 22p. (In German). Dep.

In order to manufacture reactor steel pressure vessels with the necessary operational safety, extensive studies must be made in addition to the usual design, calculation, and construction work. These additional studies include the research and testing of the most suitable form of the vessel parts under the greatest stress, the development and testing of the required radiation properties, development of technology for the manufacture of the complicated vessel parts, development of suitable welding procedures, and

construction of a scale model. A bibliographic review is made of the studies made in each of these areas. (J.S.R.)

36033 HYDROSTATIC EXTRUSION. Pugh, H. Ll. D. London, Institution of Mining and Metallurgy, 1969. 46p. (CONF-690519–1).

From 9th Mining and Metallurgical Congress, East Kilbride, Scotland.

The basic process of hydrostatic extrusion is described. Consideration is given to the equipment used and to the design and construction of the extrusion dies. Reasons are given for the reduction in frictional losses obtained with these dies and comparisons are made with similar extrusions through conventional equipment. The extrusion pressure/billet displacement characteristic is described and the effect upon it of process variables such as the pressure media, the lubricant, the included die angle, the billet hardness, and surface finish are discussed. Tables and curves of extrusion pressure/extrusion ratio for differing die angles and billet materials are given. Comparisons are made between calculated and experimental values of extrusion pressure. An empirical relationship between extrusion pressure, extrusion ratio, and billet hardness is derived for materials extruded hydrostatically through 45° dies. Properties of extruded materials are tabulated and discussed and comments are made on the results of other workers in the field. The hydrostatic extrusion of complex shapes is considered and the results are tabulated; the extrusion of composite products is also described. Methods of controlling the billet speed during hydrostatic extrusion by indirect means such as viscous damping are discussed and illustrated. Methods of direct control of the process by billet or product assistance are discussed and machines based on these methods of control are described and evaluated. Combined hydrostatic extrusion and drawing is discussed for the production of rigid and flexible products and a description of a machine at present in use at NEL for the combined hydrostatic extrusion and drawing of fine wire products is given. The feasibility of continuous wire extrusion is discussed and a method is described of semi-continuous or intermittent hydrostatic extrusion. (auth)

36034 STRUCTURAL MEMBER FOR A NUCLEAR REACTOR COOLED BY CARBON DIOXIDE. (to Commissariat a l'Energie Atomique). French Patent 1,492,989. Filed July 11, 1966.

A Be-alloy for the manufacture of structural members for CO_2-cooled nuclear reactors, particularly fuel element cans is described. The alloy containing 0.05 to 30 wt % of Ca and/or 0.05 to 3.0 wt % of Mg and 0.1 to 3.0 wt % of Cu, the remainder being Be and unavoidable impurities. (NPO)

36035 STRUCTURAL MEMBER FOR A FAST NUCLEAR REACTOR COOLED BY LIQUID SODIUM. (to Commissariat a l'Energie Atomique). French Patent 1,473,178. Filed Jan. 20, 1966.

A V-alloy for the manufacture of structural members for fast nuclear reactors cooled by liquid sodium, particularly a fuel element can is described. The alloy contains 0.2 to 3.0 wt %, preferably 0.5 to 1.0 wt %, of Si, less than 500 ppM by weight of oxygen and carbon and less than 300 ppM by weight of nitrogen, the remainder being V. (NPO)

36036 ANTIFRICTION CLADDING FOR STRUCTURAL MEMBERS OF NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,476,662. Filed Feb. 1, 1966.

A process for applying an antifriction cladding, consisting of 85 to 95 wt % of Mo, 0.1 to 2 wt % of Mo-oxide and 3 to 15 wt % of carbon and graphite, to Zr, Zr alloy, or stainless steel structural members of reactors is described. The process is comprised of cleaning and sand blasting the surface to be clad; coating the surface with a layer of Mo having a thickness in the range 0.1 to 0.4 mm by means of an oxyacetylene spray gun fed with a Mo-wire of nuclear quality; impregnating the Mo layer with a suspension consisting of 10 to 20 wt % of a mixture of nuclear graphite having a particle size of about 0.05 μ and carbon black, and 80 to 90 wt % of a purified oil, e.g., refined fish oil, and subjecting the coated structural member to a heat treatment at a temperature in the range 200 to 390°C for 6 to 8 minutes to remove the oil. (NPO)

36037 STRUCTURAL MEMBER FOR A FAST NUCLEAR REACTOR COOLED BY LIQUID SODIUM. (to Commissariat a l'Energie Atomique). French Patent 1,473,176. Filed Jan. 20, 1966.

A V-alloy is described for use in the fabrication of structural members of fast reactors cooled by liquid sodium, e.g., fuel cans. The alloy contains 0.5 to 20 wt %, preferably 5 wt % of Cr, less than 500 ppM by weight of oxygen and carbon and less than 300 ppM by weight of nitrogen, the remainder being V. (NPO)

36038 AIR AND SPACE FRONTIERS CHALLENGE WELDING. Weld. Eng., 54: 39–44(Jan. 1969).

Recent innovations and improvements in equipment and/or techniques used in Tig, Mig, flash, resistance, friction, ultrasonic, and electron beam welding and diffusion bonding of components of air and space vehicles are reviewed. Experimental and/or industrial applications of one or another of these processes in joining or repairing specific assemblies of such materials as Ni, Ti, Al, Be, and their alloys are discussed along with steels and superalloys. (Metals Abstr.)

36039 WORKABILITY OF MOLYBDENUM-BASE ALLOY WITH 0.5 PERCENT Ti IN TUBE-MILL ROLLING. Musorina, I. E.; Vitorskii, Ya. M. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 53, 48–52(1967). (In Russian).

Experiments were conducted to develop a technology for the production of seamless tubes from a molybdenum-base alloy containing 0.5% Ti. To determine the ductility of the alloy, forged and subsequently machined solid conical billets 48/38 mm in diameter, and cylindrical billets 48 mm in diameter with a 13 mm bore were pierced and rolled at 1400°C into 42.5 × 6.75 mm tubes. The metal was found to be highly ductile at 1400°C under conditions of helical rolling. However, at room temperature the metal was very brittle because of the high temperature at the end of rolling, which resulted in an almost complete recrystallization and consequent deterioration of the plastic properties of the metal. In further experiments, satisfactory tube shells 49 × 9.5 mm in size were obtained by piercing solid billets at 1300°C. Hot rolling of tube shells at 1360 to 1115°C showed that high quality tubes 42 to 42.5 × 6.5 to 7.0 mm in size can be produced by rolling at 1115°C. The tube metal has a fine-grained structure, a tensile strength of about 90 and 10 kg/mm^2 at 20 and 1200°C, respectively, and a respective elongation of about 9 and 16%. After machining down to 41 × 5.5 mm dimensions, the tubes were satisfactorily warm rolled at 450 to 550°C into tubes 32 × 3.5 mm in size. Thus, the recommended optimum technology consists in piercing tube billets at 1300°C followed by hot rolling at 1115°C and warm rolling at 450 to 550°C. (JPRS)

36040 VAPOUR DEPOSITION OF METAL BY DISPROPORTIONATION REACTION [IN PLATING AND REFINING]. Gabe, D. R. Metal Finish. J. (London), 14: 393–6(Dec. 1968).

Characteristics of disproportionation reactions are briefly discussed and commercial processes based upon these principles are outlined. These reactions are utilized both in the refining of metals and in coating metal and non-metal substrates with a thin layer of metal from the vapor or gaseous phase. Examples cited include processes involving carbonyl (Ni, Fe, Mo, W), halide (Ti, Zr, Th), and sub-halide (Al) carrier phases. A general thermodynamic treatment of the disproportionation reaction is suggested and kinetic effects are considered. Advantages, when used for coating formation, are discussed. (Metals Abstr.)

36041 IMPROVEMENT IN THE MANUFACTURE OF TUBULAR NUCLEAR FUEL ELEMENTS. (to United Kingdom Atomic Energy Authority). French Patent 1,434,757. Filed May 24, 1965.

Manufacture of tubular fuel elements by extruding a composite slug incorporating an outer and an inner aluminum or Al-alloy sleeve and a layer of a nuclear fuel alloy interposed between the outer and inner sleeves is described. In order to improve the metallurgical bond at the interfaces of the sleeves at least a portion of the surfaces of the inner and outer sleeves adjacent the fuel sleeve is anodized by the chromic acid process before extrusion. Preferably the assembled slug is swaged in a counter direction to the direction of extrusion in order to remove any radial clearance between its components and is then dehydrated by heating at a temperature of 625°C under vacuum conditions for at least 2 hours. In a modification, the inner and outer sleeves are formed with shoulder portions such that when the sleeves are concentrically assembled an annular space is provided for the nuclear fuel; shoulder portions are anodized. In another modification, a composite sleeve is interposed between the inner and outer sleeves, the composite sleeve comprising alternate segments of nuclear fuel and aluminum or Al-alloy and after extrusion the element is split lengthwise through the portions circumferentially separating the fuel portions, thus forming arcuate fuel plates which may be rolled flat. (NPO)

36042 ELECTRODEPOSITION OF RHENIUM. Meyer, Andre R. Trans. Inst. Metal Finish., 46: 209–11(1968).

Studies on the formulation of baths and operating conditions for electrodeposition of Re are reported. An improvement in existing formulations was obtained, the deposit characteristics being improved by the addition of Mg sulphamate, $(NH_4)_2SO_4$, and H_2SO_4 solution to lower the pH to 1 to 1.5. Cathode efficiency for deposition of pure Re is low and under preferred operating conditions is

~10 to 20%; alloyed Re deposits can be obtained with a higher cathode efficiency (80 to 90%). The mechanism of Re discharge is considered; discharge from the cation Re^{7+} is more likely than direct reduction of ReO_4^-. 17 references. (Metals Abstr.)

36043 URANIUM ALLOY AND PROCESS FOR ITS PREPARATION. (to Commissariat a l'Energie Atomique). French Patent 1,447,460. Filed June 18, 1965.

A U-alloy is described with fine α and γ grains containing 0.8 to 1.5 wt % of Mo and 350 to 1500 ppM of C, the remainder consisting of U and unavoidable impurities. The alloy is prepared by vacuum melting of a U-Mo-alloy containing 0.8 to 1.5 wt % of Mo, carburization of the alloy to a content of between 350 and 1500 ppM, and vacuum casting. Preferably the carburization is carried out by holding the molten alloy in a graphite crucible, the inside of which has a porous refractory lining. (NPO)

36044 IMPROVEMENT IN URANIUM ALLOYS. (to Compagnie pour l'Etude et la Realisation de Combustibles Atomiques). French Patent 1,458,144. Filed Apr. 3, 1965.

An improved U-alloy is described which retains a fine-grained primary structure over a wide range of cooling rates, e.g., from 15 to 100°C per minute. The improvement consists in adding, besides known components effecting a fine-grained structure such as Mo, Cr, Fe, Si and Ge, a minute quantity, e.g., from 5 to 2000 ppM, of B (enriched with ^{11}B) or Be to the alloy. (NPO)

36045 NATURE OF THE INTERACTION BETWEEN REFRACTORY METALS AND GRAPHITE ON VACUUM DEPOSITION. Kostikov, V. I.; Kudinov, V. V.; Skuridin, B. V.; Shesterin, Yu. A. Fiz. Khim. Obrab. Mater., No. 1, 80-5(Jan.-Feb. 1969). (In Russian).

The nature of the interactions taking place between graphite substrates and vacuum-deposited coatings of refractory metals (Ti, Nb, and Mo) immediately after deposition is discussed. As the coating is becoming attached to the substrate the immediate reaction between the two phases is of a chemical nature, resulting in the formation of carbides; later, diffusion processes set in and become dominant. The diffusion of the C into Ti, Nb, and Mo coatings produced by the plasma technique is much faster than in the case of the bulk metals. (Metals Abstr.)

36046 URANIUM ALLOY AND METHOD FOR ITS PREPARATION. (to SNAM-SpA). French Patent 1,463,632. Filed Jan. 14, 1966.

The preparation of a U-alloy containing 0.05 to 0.3 wt % of Cr and preferably 0.8 to 1.2% of at least one metal of Nb, Zr and Mo is described. The remainder of the alloy consists of U and incidental impurities which form a dispersion of fine γ-phase grains in a matrix of α-phase grains, the latter having dimensions not exceeding 40 μ. The method for its preparation comprises the following steps: cooling the alloy in the γ-phase at a rate of 50 to 300°C per minute, reheating it into the β-phase and annealing it for a time not exceeding 3 hours, cooling it to room temperature at a rate of 4 to 400°C per minute and finally reheating it into the α-phase. (NPO)

36047 RESISTANCE SPOT WELDING OF GALVANIZED STEEL. I. INFLUENCE OF WELDING VARIABLES. Lavery, R. C.; Williams, N. T. Metal Constr. Brit. Weld. J., 1: 79-81 (Feb. 1969).

Welding variables such as machine design, electrode characteristics, and welding schedules and their effects are discussed. In the design of spot welding electrodes the two main criteria are the electrode material and the electrode shape. By a suitable choice of electrode material the tendency for alloying to occur between the electrode and the galvanized coating during welding can be minimized. Among materials investigated were Cd–Cu and Cr–Cu alloys. The latter are improved by Zr additions. The electrode shape and cooling are also important in obtaining long electrode life. Other parameters such as weld current, weld time, hold time, and electrode force are discussed briefly. (Metals Abstr.)

36048 UAl_3–Al INSTEAD OF UAl_3–Al IN FUEL-ELEMENT PLATES FOR ADVANCED TEST-REACTORS. Thuemmler, F. (Kernforschungszentrums, Karlsruhe, Ger.); Lilienthal, H. E.; Nazare, S. Powder Met., 12: 1-22(Spring 1969).

Existing literature on UAl_3–Al dispersions is surveyed and a comparison is made with similar data for UAl_3–Al dispersions. Experimental work included the preparation of a practically single-phase UAl_2 compound by induction-melting and grinding to a predetermined particle size. The blending of UAl_2 and Al powders into suitable dispersions and their compaction by cold pressing to the densities required for roll-bonding are described. The picture-frame technique was used to clad the dispersions with Al for test-plates for irradiation experiments. The kinetics of the UAl_2 and UAl_3 solid-state reactions with Al are considered on a qualitative basis. Comparison is made with the known technology of UAl_3–Al dispersions, taking into consideration uranium densities, production aspects, pyrophoricity, volume changes, etc. It is concluded that UAl_2–Al dispersions have potential applications as fuels for advanced test reactors. (auth) (UK)

36049 PROCESS FOR THE MANUFACTURE OF NUCLEAR FUEL PLATES. (to Commissariat a l'Energie Atomique). French Patent 1,449,867. Filed July 7, 1965.

A process for the manufacture of clad nuclear fuel plates is described in which both end-faces of a rectangular nuclear core plate consist of U- or Pu-alloy with a tapered ridge. The core plate is surrounded by a frame of equal thickness which consists of a cladding metal such as Al or an Al-alloy, and which is composed of two end-pieces and two lateral pieces, the end-pieces being provided with a V-shaped groove for engagement with the tapered ridge, and the lateral pieces engaging the lateral faces of the core plate with interposition of a metal ribbon consisting of an alloy which has a lower melting point than the core and frame alloys and which is able to form intermetallic compounds with the alloys. The main surfaces of the core plate and the frame are covered with a sheet of cladding metal. The assembly is heated at a temperature above the melting point of the ribbon, and bonded together by rolling in a direction perpendicular to the end-pieces. The ribbon should not exceed 0.1 mm thickness and is composed of Al containing 12.5 wt % Si and 0.01 wt % Na. (NPO)

36050 EFFECTS OF FABRICATION PARAMETERS ON TEXTURES PRODUCED IN ZIRCALOY CLADDING. Hobson, D. O.; Tenckhoff, E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 134(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36051 EVALUATION OF TITANIUM-MODIFIED TYPE-304L STAINLESS-STEEL TUBING. Nilsson, T. M.; Reimann, G. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 134-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36052 AN IMPROVED CRUSHING METHOD FOR UAl_x FUEL PARTICLES. Copeland, G. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 97-8(June 1969).

36053 STUDIES OF Cu–Fe–Ti AND Cu–Fe–Zr ALLOYS. PART 2. THE PROCESS OF SEGREGATION. Daut, Hans Heiner (Forschungsinstitut fuer NE-Metalle, Freiberg, Ger.). Neue Huette, 14: 103-6(Feb. 1969). (In German).

In supersaturated Cu–Fe alloys γ or α iron is precipitated at the corresponding annealing treatment. Ti or Zr additions seem to cause a compound formation. In Cu–Fe–Ti alloys FeTi or Fe_2Ti appears and in Cu–Fe–Zr alloys a similar phase is assumed after annealing. Cold deformation before the annealing increases the precipitation rate and the degree of precipitation. After corresponding pretreatment the alloys T 9, Z 1, and Z 4 possess both very good mechanical and electrical properties ($\varkappa$ = 33 to 40 m/Ωmm^2; σ_B = >72 kg/mm^2) connected with a high annealing stability (T_E = 600°C). These alloys are suitable for use in electrical and mechanical highly stressed components such as point weld electrodes, collectors, and overhead line armatures. (tr-auth)

36054 DISPERSED-PHASE ALLOY IN THE Al–$NbAl_3$ SYSTEM BY ULTRA-RAPID QUENCHING FROM THE LIQUID STATE. Beghi, G.; Matera, R.; Piatti, G. (CCR-EURATOM, Ispra, Italy). J. Nucl. Mater., 31: 259-68(July 1969). (In French).

A dispersed-phase alloy in the Al–$NbAl_3$ system was obtained by using a technique of ultra-rapid quenching from the liquid state. The rates of cooling obtained were of the order 10^{6}°C/sec, which created particles of $NbAl_3$ of diameter 0.2 to 0.4 μm, dispersed in an aluminum matrix, with an interparticle distance of 1 to 2 μm. The small alloy pieces were obtained in the form of sheets 70 to 80 μm in thickness and were subjected to a series of cold and hot compaction processes and of rolling which finally produced the Al–$NbAl_3$ alloy in the form of thicker sheets. Samples were taken from these sheets for tests of thermal stability, cold and hot mechanical characteristics (up to 450°C) with the aim of testing the possible value of this alloy system for applications in the nuclear field. (auth)

36055 IMPROVEMENTS IN OR RELATING TO COMPACTION PROCESSES. Butcher, John William; Samuel, Robert Lionel

(to United Kingdom Atomic Energy Authority). British Patent 1,156,843. July 2, 1969. Filed June 20, 1966.

Reference is made to British Patent 1,090,263 which describes a process for hot pressing metal powder particles having a surface coating of an inert film of a compound of the metal, which serves as a barrier to the formation of metal-metal bonds between the particles. A valency imbalance is established in the solid film by applying to the particles an activating element having a stable valency different from the particle metal and an interatomic distance which permits atoms of the activator to displace atoms of the metal in the film lattice, the quantity of activating element being sufficient to promote diffusion of the metal through the solid film at the sintering temperature, but insufficient to form a distinct phase with this metal. The particles are hot pressed to achieve sintering. According to the present specification the metallic particles are wholly or largely Cr, Nb, W, Fe, or stainless steel; the activating element may be added as an inert volatile compound which decomposes below the hot pressing temperature, and may be Si or Mo. (UK)

36056 MOLYBDENUM IN HOTWORKING TOOLS AND DIES. PART 2. Burman, Russell W.; Braun, Horst (Climax Molybdenum Co., Ann Arbor, Mich.). Precis. Metal Molding, 26: No. 8, 44; 66-7(Aug. 1968).

Present and potential uses of Mo and Mo alloys, particularly TZM alloy, for cores in die casting of Al and Zn alloys and brass and for permanent mold casting of Al and Cu alloys are reviewed and advantages are enumerated. The potential of Mo can be used in full cavity molds for the die casting of brass and higher melting-point metals, including ferrous metals, and for permanent mold casting of gray iron. In the die-casting field, TZM is most widely used for Al. The behavior of TZM cores used in die casting such Al items as carburetor bodies, automotive horns and trim and switch housings is described. In permanent mold casting, the applications of TZM have been limited to cores for casting Al alloys, especially the more critical uncooled deep cores or gate-situated cores. A new process under development involves simultaneously casting and working nonferrous metals and alloys. The casting and combination shear-pierce-forge operations are done in water-cooled dies, with TZM as an uncooled lower working die. Bottom feeding of the molten metal is followed by mechanical working with a TZM die insert. (Metals Abstr.)

36057 CATHODIC FABRICATION OF NUCLEAR FUELS AND THEIR CLADDING. Raviv, S.; Rabinovitz, E.; Malkieli, S. (Nuclear Research Center Negev, Beer-Sheva, Israel). J. Nucl. Mater., 31: 300-6(July 1969). (In French).

A new method of fabrication is described, using an electrolytic circuit in which the electrolyte is nitric acid and the electrodes are inert towards the electrolyte under the conditions of electrolysis used. The materials to be shaped are immersed in the electrolyte at a certain distance from the cathode, and the electric current passing through the circuit causes local dissolution of the material which is to be shaped; this dissolution can be controlled by means of various parameters, such as the concentration of acid, temperature, form and nature of the electrode, current density, etc. Various forms of shaping, such as piercing and slicing, which have been effected with uranium and 18/8 stainless steel, are described. This technique, which employs simple apparatuses, can find application in the nuclear industry for the shaping of contaminated materials which cannot be worked by means of conventional methods. (auth)

36058 ANODIC BEHAVIOUR OF LOW MOLYBDENUM–URANIUM ALLOYS AT HIGHER ELECTROLYTE TEMPERATURES. Mance, A. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Nucl. Mater., 31: 252-8(July 1969).

The effect of the temperature of the electrolyte on the kinetics of the anodic dissolution of α-uranium in the homogenized state and the U–0.45 wt % Mo alloy in the homogenized and in the β-quenched states is investigated. The Tafel coefficients a and b and the activation energy of the process of anodic dissolution were determined. It was found that the electrolyte temperature shifts the polarization curves towards the more negative potentials, i.e., accelerates the process of anodic dissolution. The position of the transpassive part of the curve is also dependent on the structure state of the specimen. The dissolution potential of the two-phase ($\alpha + \gamma_1$) state is more negative than the monophase α- and β-uranium. Although it was found that α- and β-uranium display a similar behavior, their activation energies of dissolution are different at constant potential, which may be attributed both to different crystallographic characteristics of these phases and to the presence of the molybdenum atom in the β-phase. (auth)

36059 PROCESS FOR INTERNAL SHEATHING OF TUBULAR NUCLEAR FUEL ELEMENTS. (to Snam Progetti SPA). French Patent 1,488,800. Filed Aug. 5, 1966.

A process is described for providing a tubular fuel body consisting of U or a U-alloy with an internal metal sheath consisting of Zr or Zr-alloy, Al or Al-alloy, or stainless steel. The process comprises introducing a tube of the sheathing metal having a temperature between −80 and −250°C into the tubular fuel body, the inner diameter of the latter slightly exceeding the outer diameter of the metal tube in the contracted state, and then raising the temperature to room-temperature to dilate the metal tube so as to obtain a close contact between the tube and the fuel body. In a modification the tube of sheathing metal has a temperature above −80°C and close contact is established partly by thermal expansion and partly by plastic deformation by mechanical means. The resulting unit is then heated from the inside and cooled from the outside to effect an intermetallic diffusion between the sheathing metal and the fuel body. (NPO)

36060 A NEW INTER-DIFFUSION TECHNIQUE FOR PREPARING ALLOYS OF Cd–Zr SYSTEM. Arunsingh; Dayal, B. (Banaras Hindu Univ., India). Z. Metallk., 60: 610-13 (July 1969).

A new interdiffusion technique has been developed to produce alloys of Cd–Zr system. This method produces alloys in a very short time. Its theory has been worked out on the mechanism of vacancy diffusion. The two phases of this system earlier reported have been verified and a third new orthorhombic phase has been detected. An attempt has also been made to show how atomic vibrational frequency ratio guides formation of compounds. (auth)

Properties Evaluations

Refer also to abstracts 35075, 35405, 35434, 35438, 36054, 36056, 36151, 36152, 36154, 36281, and 37089.

36061 (AGN-8191(Vol.3)) ALKALI METALS EVALUATION PROGRAM: SURFACE TENSION AND CONTACT ANGLE OF LITHIUM AND SODIUM. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Div.). Apr. 1969. Contract AT(04-3)-368. 78p. Dep. CFSTI.

The surface tension and contact angle of pure lithium were determined at temperatures from 210 to 617°C and 206 to 563°C, respectively. The surface tension and contact angle of lithium containing various amounts of nitrogen impurities were determined at temperatures from 224 to 514°C. The surface tension and contact angle of lithium containing 3000 ppM oxygen were determined at temperatures from 212 to 545°C and the surface tension and contact angle of sodium containing from 37 to 190 ppM oxygen at temperatures from 114 to 564°C. The maximum bubble pressure method was used for the surface tension determinations and the dip tube method for the contact angle determinations. The tests were performed with a specially designed apparatus fabricated from Type 410 stainless steel. The capillary tubes and the dip tube were made of Type 304 stainless steel. (auth)

36062 (BM-RI-7222) SOME STRAIN-AGING EFFECTS IN ELECTROREFINED VANADIUM. Keith, George H.; Iverson, H. G. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Feb. 1969. 26p. Bureau of Mines Free.

Oxygen and nitrogen cause strain aging in electrorefined vanadium, as evidenced by maxima in yield and tensile strengths and by Snoek internal friction peaks. Alloys containing up to 0.22 percent oxygen and 0.11 percent nitrogen were investigated. Tensile strengths of oxygen- and nitrogen-containing alloys were 66,000 and 68,000 psi at 300 to 400°C, compared with 53,000 and 62,000 psi, respectively, at room temperature. Total elongation decreases to about 7 percent at the temperature of maximum strength. At 600°C, strain aging is not evident. Based on interstitial contents calculated from internal friction measurement, the increases in strength caused by nitrogen and oxygen were 440,000 psi per weight-percent nitrogen and 260,000 psi per weight-percent oxygen. Application of the Schoeck and Seeger treatment to the Snoek effect in these systems results in a calculated lattice distortion of 0.24 and 0.15 caused by the presence of an interstitial nitrogen or oxygen atom, respectively. Alloys containing boron or carbon were also investigated. Both elements refine the grain size but have no other effect because of their low solubility in vanadium. (auth)

36063 (BNWL-1071) INTERDIFFUSION BETWEEN CERTAIN VAPOR DEPOSITED-FOIL REFRACTORY METAL COUPLES. Steichen, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 19p. Dep. CFSTI.

A study was conducted to determine the extent of interdiffusion between refractory metal couples which had been partially or completely prepared by chemical vapor deposition. The couples

which were tested included tungsten-iridium, tungsten-rhodium, rhenium-tungsten, and tantalum-tungsten. At the completion of the diffusion annealing, metallography, and electron microprobe scans it was concluded that the rhenium-tungsten couple was the most compatible of those tested. (auth)

36064 (BNWL-1076) FATIGUE CRACK GROWTH AND PROPAGATION IN Zr-2.5 WT PERCENT Nb ALLOY PRESSURE TUBING. Pankaskie, P. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 29p. Dep. CFSTI.

Tubes of Zr-2.5 wt % Nb alloy were fatigued in the tension-tension mode by cyclic internal pressures to cause axial crack growth and unstable fractures at room temperature. Pressure cycle rates were 400 and 3000 cycles per hour. Both the cold worked and heat treated conditions, before and after hydriding (200 to 300 ppM H_2), were investigated. Exploratory tests were done to determine the effect of the axial length of the surface stress intensifying defect, and multiple surface stress intensifying defects on fatigue crack initiation, growth, and critical length at unstable fracture. From short (less than or equal to tube wall thickness) length defects, fatigue crack initiation and growth will occur at nominal peak hoop stresses equal to or less than the estimated endurance limit (about 25,000 psi). For fatigue cracks initiated at the outer diameter surface, the shape of the crack front is semicircular. The number of stress cycles required to initiate fatigue cracking at the surface is inversely proportional to the square of the surface defect length. Crack growth rates for nonhydrided tubing are proportional to ΔK to the fifth power and to the fourth power after hydriding. There was a tendency for the critical crack length at unstable fracture to decrease with an increase in the number of fatigue cycles required to initiate fatigue cracking. Multiple defects may act in concert to initiate unstable fracture. The fracture toughness of the heat treated tubing before hydriding is less than for the cold worked condition either before or after hydriding; after hydriding the fracture toughness is further reduced. In the 30% cold worked condition, irradiation to 10^{20} nvt has little effect unless hydrided; when hydrided, fracture toughness is reduced substantially. (auth)

36065 (BNWL-1077) CREEP OF Zr-2.5 WT PERCENT Nb ALLOY PRESSURE TUBES. Pankaskie, P. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

Creep and stress rupture data were obtained from prototypic reactor pressure tubing. Biaxial stress conditions, with a hoop to axial stress ratio of 2 to 1, were maintained by a constant internal pressure. Most of the testing was done at 400°C on tubing in the heat treated condition. Some tests were done at 300°C on tubing in the 30 and 60% cold work temper. The data obtained suggest that the heat treated condition is sufficiently stable for use at 400°C. (auth)

36066 (EUR-4229(Pt.1)) DECANNING OF UO_2-PuO_2/INOX FUELS BY LIQUID METALS. PART I. SEARCH FOR A SOLVENT ALLOY. Payrissat, M.; Wurm, J. G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct. 28, 1968. 40p. (In French). Dep.

A new decanning process using liquid metals is presented that is able to dissolve the stainless steel sheaths at temperatures below 1000°C. The experimental study shows excellent dissolving properties of a Sb-Cu alloy for a large variety of stainless steels. Various dissolution curves summarize the results. (auth)

36067 (EUR-4243) PYROMETALLURGICAL CONCENTRATION OF ENRICHED URANIUM IN IRRADIATED MTR FUEL ELEMENTS. David, C.; Junger, J. M.; Lorenz, R.; Montellanico, P.; Wurm, J. G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 29, 1968. 20p. (In French). (CONF-681040-14). Dep.

From Symposium on Nonaqueous Reprocessing, Mol, Belgium.

The process, performed on the MTR reactor site, reduces the transportation costs of the uranium to the aqueous plant and the processing costs (reduced handling, smaller liquid waste volume). The method consists in melting down the fuel element (aluminum type) and concentrating the fissile material by precipitation through the addition of magnesium in which uranium is insoluble. The enriched uranium, concentrated at the bottom of the ingot as an intermetallic compound (UAl_3), is cut off and shipped away. The laboratory experiments indicated that a uranium volume concentration of 20 to 1 is possible. A furnace has been installed in the hot cell of the Ispra I reactor to melt spent MTR fuel elements. The first experiments performed on MTR mockup elements have demonstrated that the same results as for the laboratory experiments can be obtained. (auth)

36068 (GEMP-685) CREEP-RUPTURE DATA FOR THE REFRACTORY METALS TO HIGH TEMPERATURES. Conway, J. B.; Flagella, P. N. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Mar. 1969. Contract AT(40-1)-2847. 986p. (R-69-NSP-9). Dep. CFSTI.

A comprehensive compilation of creep-rupture data for the refractory metals to 3000°C is presented. Chapters are included on tungsten, rhenium, tantalum, molybdenum, and niobium, as well as the alloys of the metals. A chapter is devoted to the mathematical techniques useful in the analysis of creep data, a chapter is devoted to parametric correlations of stress-rupture data, and a chapter is devoted to experimental procedures pertinent to the measurement of the creep-rupture behavior of refractory metals at elevated temperatures. Special attention has been given to the data accumulated over the past seven years in the AEC-sponsored refractory metal evaluation program conducted at GE-Nuclear Systems Programs. (auth)

36069 (GEMP-697) A NEW APPROACH TO THE PREDICTION OF LOW-CYCLE FATIGUE DATA. Berling, J. T.; Conway, J. B. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). May 1969. Contract AT(40-1)-2847. 25p. (CONF-690507-2). Dep. CFSTI.

From AIME Spring Meeting, Pittsburgh, Pa.

Low-cycle fatigue data for annealed AISI Type 304, 316, and 348 stainless steel to 816°C have been analyzed and a new relationship has been identified associating fatigue data with short-term tensile behavior. A logarithmic plot of plastic strain range versus time to fracture was shown to be linear with a slope of minus unity. This line was also found to originate at the point corresponding to the tensile ductility. A similar analysis for elastic strain range data revealed a relationship with the strain-hardening exponent measured in a short-term tensile test at the same temperature and strain rate. These correlations have been combined to provide an equation for predicting the relation between total strain range and cycles to fracture. This approach has been termed the Method of Specific or Characteristic Slopes. (auth)

36070 (KFK-924) CHARACTERISTICS OF SODIUM. Pee, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Feb. 1969. 91p. (In German). (EUR-4168). Dep.

A number of FORTRAN-4-functions were described with which the entropy of sodium could be calculated in the temperature range from 260 to 1400°C. (J.S.R.)

36071 (KFK-927) A HIGHLY PURIFIED GAS BLANKET FOR THE CHARGE OF HIGH MELTING REACTIVE METALS AT HIGH TEMPERATURE. Bukau, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reactorentwicklung). Dec. 1968. 47p. (In German). Dep.

The use of high melting metals at high temperatures requires a protection of the surface of these metals from undesirable gas absorption. A highly purified gas blanket for the protection of reactive metals was investigated on Nb and Ta. The effect of H_2, O_2, and N_2 on the properties of Nb and Ta was determined qualitatively and quantitatively. The gas blanket can consist of either argon or helium. The gas blanket system designed and its operation are described. (J.S.R.)

36072 (LA-4136) DUCTILITY STUDIES ON SINTERED TUNGSTEN-MOLYBDENUM-RHENIUM ALLOYS. Lenz, W. H.; Riley, R. E. (Los Alamos Scientific Lab., N. Mex.). Feb. 20, 1969. Contract W-7405-eng-36. 12p. Dep. CFSTI.

A Brinell brittleness test developed several years ago has undergone considerable experimentation with regard to optimum specimen diameter and thickness. A new, slightly larger, specimen size was used for more sensitive ductility measurements of sintered W-Mo-Re alloys with 0 to 8 at. % Re. A possible heat treatment for such alloys to restore ductility normally lost through grain growth appears evident. (auth)

36073 (NP-tr-1818) STRENGTH OF HARD ALLOYS. Kreimer, Gersh S. Translation of Prochnost' Tverdykh Splavov, Metallurgiya Press, Moscow, 1966. 166p.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 34115.

36074 (TRG-Report-1789) EFFECTS OF NEUTRON IRRADIATION ON THE CREEP-RUPTURE PROPERTIES OF TYPE 316 STAINLESS-STEEL TUBES. Standring, J.; Bell, I. P.; Tickle, H.; Glendinning, A. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). Nov. 14, 1968. 13p. (CONF-680604-14; JNPC-FEWP(CPSG)P-(68)48; FRPMC-FEWP-P-(68)486. Dep.

From Symposium on Radiation Effects to Reactor Metals, San Francisco, Calif.

The effects of irradiation in the Dounreay Fast Reactor and the Dounreay Materials Testing Reactor on the creep-rupture properties of Type 316 stainless steel tubing have been investigated. DFR irradiation produced a loss of rupture ductility but, in general, no change in creep strength in 650°C biaxial tests of solution-treated material. Cold-worked tubes suffered a loss of 550°C creep strength. Irradiation of solution-treated tubes at 650°C in DMTR caused a severe loss of high-temperature ductility and a ten-fold reduction of creep rate both during and after irradiation. It is possible that an irradiation-induced carbide precipitation process is responsible for the increase of creep strength. (auth)

36075 (TRG-Report-1797) DISLOCATION ATMOSPHERE FORMATION AND STRAIN-AGEING EFFECTS IN NIOBIUM. Szkopiak, Z. C. (Surrey Univ., Guildford (England). Dept. of Metallurgy and Materials Technology). Nov. 6, 1968. 12p. Dep. CFSTI. UK 2s.

Yield point return and internal friction results of strain-aging in niobium were analyzed using the Cottrell–Bilby $t^{\frac{2}{3}}$ law of solute segregation. It was suggested that the difference in the kinetics of aging, as measured by the two techniques, is primarily affected by the dislocation structure prior to aging. Calculations, from the internal friction results, produce dislocation densities which are proportional to the square root of both the true strain and total oxygen content. Dislocation atmosphere densities have also been found to be proportional to the square root of oxygen content. The k_y and $\Delta\sigma_f$ parameters, given by $\Delta\sigma_y = \Delta\sigma_f + 2k_y d^{-\frac{1}{2}}$, were correlated with dislocation atmosphere densities. The k_y parameter is directly proportional to the number of atoms in the Cottrell atmosphere, the density of which appears to be dependent on the total oxygen content. $\Delta\sigma_f$, on the other hand, shows a logarithmic relationship with "outer atmospheres." The total dislocation atmosphere density for the fully-strain-aged condition is about 2.5 times the Cottrell atmosphere density. (auth)

36076 (UCRL-16988) VISCOSITY OF URANIUM METAL AND SOME URANIUM-CHROMIUM ALLOYS. Finucane, James Single (California Univ., Berkeley. Lawrence Radiation Lab.). May 1969. Contract W-7405-eng-48. 48p. Dep. CFSTI.

Thesis.

An oscillating crucible viscometer capable of precise viscosity determinations above 1000°C was constructed. The operating details were developed and the viscosity of uranium metal and two uranium-chromium alloys was measured. (auth)

36077 (ZJE-45) STRENGTH AND BRITTLE FRACTURE RESISTANCE OF LARGE WELDED BODIES. Kalna, K. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). Jan. 1969. 30p. Dep.

The mechanical characteristics of test specimens have a very similar temperature dependence with various form and size of specimens and with various type of tests. The most variable characteristic is the transition temperature. The size effect on mechanical properties of a low-alloyed steel and an aluminum alloy during static tests of specimens having cross-sections of 0.3 to 2400 cm^2 and during crack arrest tests of specimens 50, 200, and 300 mm in thickness was studied. The diagrams of mechanical characteristics to size of cross-section dependence are presented. It has been proved by the tests of large welded plates that conventional tests provide sufficiently rigorous criterion for checking of the material quality, weld processing, and heat treatment. However, the correlation between Charpy-V transition temperatures and crack arrest temperature must be determined precisely, if the operational temperature lies near the expected crack arrest temperature. This determination can be done only on test specimens which have a real or limiting thickness and are fabricated using the same technology. (auth)

36078 FIZICHESKAYA PRIRODA PLASTICHESKOI DEFORMATSII I RAZRUSHENIYA METALLOV. (Physical Nature of Plastic Deformation and Breakdown of Metals). Svechnikov, V. N. (ed.). Metallurgical Series No. 21. Kiev, Izdatel'stvo Naukova Dumka, 1969. 136p.

Fifteen articles are included on the mechanism of plastic deformation of metals at various temperatures and conditions. The physical nature of dislocations, structural, and physical processes in chromium, iron, steel, aluminum, tin, and niobium monocrystals are discussed. Effects of thermo-mechanical magnetic treatment on coercive forces of nickel and Fe–Gd are also briefly discussed. (R.V.J.)

36079 PHYSICAL PROPERTIES OF GERMANIDES OF RARE-EARTH METALS. Rud, B. M.; Kutsenok, T. G.; Paderno, Yu. B. Porosh. Met., Akad. Nauk Ukr. SSR, No. 4, 34-7(Apr. 1969). (In Russian).

On the basis of temperature dependences of resistivity and coefficient of absolute thermo-emf of rare-earth metal germanides with compositions $MeGe_2$, MeGe and Me_5Ge_3 where Me is La, Ce, Pr, Nd, Sm, and Y, the values of Fermi energy and scattering parameters are calculated. The values of these parameters in the region of semiconducting conductivity may testify to the fact that in these compounds there is a considerable part of an ionic component of interatomic bond. (auth)

36080 NICKEL–COPPER–COLUMBIUM [NIOBIUM] STEEL COMBINES ADEQUATE STRENGTH WITH DUCTILITY AND EASE OF WELDING. Cassidy, Donald P.; Shelton, C. H. SAE (Soc. Automot. Eng.) J., 77: No. 2, 38-9(Feb. 1969).

The new low C content steel obtains its excellent properties by combining Nb strengthening with the Cu age hardening of a nickel ferrite. The high strength and impact resistance of the steel are complemented by excellent weldability and cold formability in both the as-rolled or age-hardened condition. The steel can be used most in section thicknesses below 0.5 in. Two existing applications of a similar steel are a corrugated end sheet of a box car and rim punchings of a hydroelectric generator rotor. (Metals Abstr.)

36081 SOME PHYSICAL PROPERTIES OF ALLOYS OF NIOBIUM AND TITANIUM CARBIDES IN THEIR HOMOGENEITY RANGE. Samsonov, G. V.; Upadkhaya, G. Sh. (Inst. of Problems in Material Studies, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 3, 250-4(Mar. 1969). (In Ukrainian).

Parameters of lattice, microhardness, electrical resistivity, thermo-emf, Hall coefficient, and magnetic susceptibility were measured at a room temperature. Temperature dependence of electric resistivity and thermo-emf was also investigated. Extreme properties were observed in the composition $Nb_{0.5}Ti_{0.5}C_x$. (auth)

36082 SELECTION OF SLIP SYSTEMS IN TENSILE DEFORMATION OF HEXAGONAL METAL SINGLE CRYSTALS. Ruehlicke, D. (Institut fuer Metallkunde und Materialpruefung, Freiberg, Ger.). Metall, 23: 130-4(Feb. 1969). (In German).

The deformation of hexagonal metals with closely packed structure in theoretically possible and experimentally observed slip systems was investigated. Data are given for Cd, Zn, Mg, Ti, Zr, and Be. (M.C.G.)

36083 DIFFUSION OF COPPER IN IRON AND IRON–MOLYBDENUM ALLOYS. Golikov, V. M.; Lazarev, V. A. Fiz. Khim. Obrab. Mater., No. 1, 156-9(Jan.-Feb. 1969). (In Russian).

Using the method of concentration curves, with scintillation counters to record the γ radiation from tracer atoms, the characteristic volume and boundary diffusion of Cu atoms in Fe and Fe–Mo alloys were studied. The volume diffusion coefficients were almost the same for the pure Fe and the Fe–Mo alloys, but the boundary diffusion coefficient was far smaller in the Fe–Mo alloys than in the pure metal. The form of the Cu distribution curves in the two types of sample suggested that the concentration of Cu atoms at the grain boundaries was lower in the alloys than in the Fe. (Metals Abstr.)

36084 EFFECT OF THE PROPORTION OF FIBRE ON THE FATIGUE STRENGTH OF A COPPER/TUNGSTEN COMPOSITION. Deryagin, G. A.; Ivanova, V. S.; Terent'ev, V. F.; Ustinov, L. M.; Shtovba, Yu. K. Fiz. Khim. Obrab. Mater., No. 1, 117-21(Jan.-Feb. 1969). (In Russian).

The fatigue properties of Cu reinforced with W filaments (fibers) were studied; Cu containing over 10% (volume) of W had a very high fatigue resistance at 20°C. On raising the proportion of W from 10 to 37% the fatigue limit rose from 8 to 32 kg/mm^2. The high fatigue resistance was attributed to the rise in the energy corresponding to the generation and propagation of cracks due to the introduction of the fibrous components. For compositions with 3% W there was a sharp decline in fatigue limit owing to the non-uniform distribution of the fibers over the sample cross section. (Metals Abstr.)

36085 AGE-HARDENING OF Ni–2.5 WT PERCENT Be ALLOY. Kainuma, Tshio; Watanabe, Rjoji (National Research Inst. for Metals, Tokyo). Nippon Kinzoku Gakkaishi, 33: 602-6 (1969). (In Japanese).

The precipitation hardening behavior of Ni–2.5 wt % Be alloy was investigated by means of hardness measurement, electrical resistivity measurement, and optical and transmission electron microscopy. The precipitation sequence of this alloy is α (supersaturated solid solution) → Guinier–Preston zone → β' (metastable phase) → β (stable phase). The grain boundary reaction type of precipitation occurs at the grain boundary. The high age-hardening of the alloy is found to be caused by the formation of the Guinier–Preston zones and the metastable phase. The overaging of the alloy

is due to the precipitation of the grain boundary reaction type and the coalescing of the Widmanstätten type precipitates. The slow rate of decrease in electrical resistivity during the initial stage of the aging is attributed to the formation of the Guinier–Preston zones and the metastable phase, and the rapid decrease, to the precipitation of the grain boundary reaction type or the Widmanstätten type. (auth)

36086 BRAZING ALLOY FOR MOLYBDENUM. Tutorskaya, N. N.; Koroleva, S. P.; Podvigina, O. P.; Chernov, O. V.; Protasova, I. V. Svar. Proizv., No. 5, 44-6(May 1968). (In Russian).

An investigation to find a brazing alloy with a low vapor pressure, containing no precious metals, for brazing Mo to Cu, Ni, Fe, and other alloys, is described. The required material needed to be suitable for fluxless brazing of these metals in vacuum or in protective atmospheres, and to give good joint strength and consistent quality of brazing. From thermal analysis, pressure treatment characteristics, and study of alloy properties, an alloy (570) was developed of the following composition, Cu–4 to 5% Ge–2 to 3% Si. Graphs are given of the relationship of tensile strength, hardness, and percent elongation to the strain and operating temperature. A technique for making solder 570 in foil and wire form has been developed and is reported. (Metals Abstr.)

36087 A REVIEW OF THE INTERACTION OF CREEP AND FATIGUE. Ellison, E. G. (Univ. of Bristol, Eng.). J. Mech. Eng. Sci., 11: 318-39(June 1969).

Many components in modern power plant operate under cyclic temperature conditions and creep processes can occur. Solving associated material problems depends, to a major extent, on understanding the various factors influencing behavior, such as the effect of stress or strain cycling, dwell periods, temperature, notches, environment, multiaxial stress, ductility, and the effect of prior testing on subsequent endurance. The various methods of testing are briefly described and the mode of failure where there is interaction between creep and fatigue is discussed. Methods for predicting deformation and life are also presented. Suggestions for future work are made. 109 references. (auth) (UK)

36088 THE TEMPERATURE DEPENDENCE OF DEUTERIUM ION TRAPPING IN NIOBIUM, TITANIUM, ZIRCONIUM, AND ERBIUM. McCracken, G. M.; Jefferies, D. K.; Goldsmith, P. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 149-54 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.

See CONF-680401.

Measurements were made of the trapping of 18-keV deuterium ions in the chemically active metals Nb, Ti, Zr and Er, with a view to finding out under what conditions high trapping efficiencies can be achieved. The role of the hydrogen–metal binding energy was investigated and found to be a major factor in determining whether a metal will trap ions at very large doses. (auth)

36089 INTERACTION OF HEAVY PARTICLES WITH METAL SURFACES. Kistemaker, J.; Onderdelinden, D.; Saris, F. W.; Van Der Weg, W. F. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). pp 164-74 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.

See CONF-680401.

Internal and surface phenomena related to the bombardment of metal surfaces with keV-ions are discussed. From the sputtering effect new views are reported concerning the origin of the spot patterns from single-crystal surfaces. A comparison is also made between the influence of ion channelling and of random motion inside single crystals on the sputtering yield. Kinetic secondary electron emission is compared in its parameter dependence with sputtering, and the origin of surface fluorescence is referred to. Some scattering phenomena of fast ions at crystalline surfaces are discussed, such as multiple collisions and charge-changing processes, as a function of the speed of the particles relative to the surface. (auth)

36090 CURRENT PRESSURE VESSEL PROBLEMS: A COMPILATION OF PROBLEMS AND NEEDS IN THE ANALYSIS, DESIGN, AND MANUFACTURE OF PRESSURE VESSELS. Fessler, H.; Stanley, P. (eds.). Proc. Inst. Mech. Eng. (London), 182: 1-13(1967-68). (CONF-661143).

The proceedings of a meeting held on Nov. 30, 1966 by the Applied Mechanics, Nuclear Energy, Process Engineering, and Steam Plant Groups are presented. General comments, design, material studies, welds, behavior of components, and analyses of stress and strain are discussed. (UK)

36091 SOME REGULARITIES OF INTERDIFFUSION IN POWDER MIXTURES Fe–Co. Fedorchenko, I. M.; Ivanova, I. I.; Fushchich, O. I. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 4, 356-9(Apr. 1969). (In Ukrainian).

The boundary diffusion coefficient was determined by the method of spectrum analysis in the system Fe–Co at the annealing of molded powder samples. The parameter values of boundary diffusion $D_b\delta$ obtained at 850 and 1200°C proved to be approximately an order higher than in cast metals. The boundary diffusion coefficients of Co and Fe at 850°C are approximately equal, the diffusion coefficient for Fe at 1200°C is somewhat higher than that for cobalt. (auth)

36092 HIGH TEMPERATURE TESTING OF PRESSURE VESSELS. Taylor, T. E. (Univ. of Manchester, Eng.). Proc. Inst. Mech. Eng. (London), 183: 51-73(1968-69).

Creep rupture tests on three spherical vessels of aluminium killed mild steel were carried out. The vessels were identical and each contained three unreinforced protruding nozzles. Two of the nozzles of equal thickness were attached with low hydrogen or rutile weld metal. A third thinner nozzle was welded with low hydrogen electrodes. Two of the vessels were subjected to steady pressure, while in the third the pressure was relieved briefly at regular intervals. In two of the vessels repairs were effected at failure and testing continued for an arbitrary period without further failure. The tests revealed that the life of all the vessels was limited by the integrity of the weld metal. Comprehensive measurements established the patterns of strains on the outside surfaces of the vessels. These strains supported current theoretical concepts. (auth)

36093 DYNAMIC THERMOELASTIC CALCULATIONS FOR CYLINDRICAL FUEL ELEMENTS. Reuscher, J. A. (Sandia Labs., Albuquerque, N. Mex.). Trans. Amer. Nucl. Soc., 12: 315(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36094 THE BRITTLE BEHAVIOR OF ZIRCALOY UNDER EMERGENCY-CORE-COOLING CONDITIONS. Herzel, R.; Meservey, R. H. (Phillips Petroleum Co., AED, Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 355-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36095 METALLURGICAL EVALUATION OF ZIRCALOY EXPOSED TO EMERGENCY-CORE-COOLING CONDITIONS. Graber, M. J.; Zelezny, W. F. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 356-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36096 PERFORMANCE OF INCONEL-600 TUBING IN N REACTOR STEAM GENERATORS. Kratzer, W. K. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 165(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36097 CREEP EQUATIONS FOR 304 AND 316 STAINLESS-STEEL FUEL-ELEMENT CLADDING. Anderson, W. J.; Atkins, D. F.; Walter, J. H. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 136(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36098 COMPARISON OF THE THERMAL STABILITY OF TITANIUM-MODIFIED HASTELLOY N AT 650 AND 760°C. Sessions, C. E.; Stansbury, E. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 136-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36099 FAILURE CHARACTERISTICS OF FUEL CLADDING WITH BIAXIAL STRESSES AND ANISOTROPY (LWBR DEVELOPMENT PROGRAM). Duncombe, E. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 137-8 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36100 BIAXIAL CREEP-RUPTURE OF 0.2 PERCENT Ti-MODIFIED TYPE-304L STAINLESS-STEEL TUBING. King, R. T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 135(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36101 MAGNETIC SUSCEPTIBILITY MEASUREMENTS FOR FOLLOWING REACTORS IN LIQUID SODIUM. Charles, R. G.;

Haverlack, P. G. (Westinghouse Research Labs., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 122-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36102 REVERSIBILITY OF FISSION GAS SWELLING IN URANIUM. Kulcinski, G. L.; Leggett, R. D. (Battelle Memorial Inst., Richland, Wash.). J. Nucl. Mater., 31: 279-87(July 1969).

The effect of hydrostatic pressures up to 1000 bar on the behavior of pre-formed bubbles in irradiated uranium was studied. High pressure, 900°C anneals cause the fission gas swelling, induced in uranium by 600°C vacuum anneals, to be reversed. Subsequent high temperature (900 to 1080°C) vacuum tests produce the same swelling as samples vacuum annealed to identical temperatures, but without benefit of previous pressure annealing. Reheating high temperature-pressure annealed samples to 600°C produces no further swelling due to the lack of driving force for recrystallization. Pressure annealing causes a reduction in the total surface area and total number of observable bubbles as well as a lowering of the vacancy/gas atom ratio. (auth)

36103 PHASE TRANSFORMATIONS AND STRENGTHENING MECHANISMS IN THE ALLOY Ti–6Al–4V. Fopiano, P. J.; Bever, M. B.; Averbach, B. L. (Massachusetts Inst. of Tech., Cambridge). ASM (Amer. Soc. Metals), Trans. Quart., 62: 324-32(June 1969).

The effects of solution and aging treatments on the alloy Ti–6Al–4V were investigated by hardness measurements, light and electron microscopy, resistance measurements at the aging temperature, and x-ray diffraction; dilatometric, density, and room-temperature resistance measurements were also made. Two strengthening mechanisms are distinguished and can be related to the compositions of the phases present after the solution treatment. The first strengthening reaction involves the decomposition of the α' phase and has similar kinetics as the decomposition of martensite in the binary titanium-vanadium system. This reaction can occur both during the quench from the solution temperature and during aging. The second strengthening reaction is associated with the precipitation of the α_2 phase in the primary alpha lattice and is diffusion controlled. (auth)

36104 THE APPLICATION OF FRACTURE MECHANICS TO THE ASSESSMENT OF FAILURE OF CYLINDRICAL PRESSURE VESSELS UNDER YIELDING CONDITIONS. Parry, G. W.; Lazzeri, L. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Eng. Fracture Mech., 1: 519-37(Apr. 1969).

An analysis of experimental data on the fracture of cylindrical pressure vessels containing longitudinal full thickness defects showed good agreement with the Griffith–Irwin ($\sigma^2 c$ = const.) fracture criterion for flat plates if appropriate corrections were made for bending and extensional stresses and for yielding at the crack tip. The resulting equation was found to be applicable for a wide range of materials and vessel sizes covering plane strain and plane stress failures, while the Griffith–Irwin ($\sigma^2 c$ = const.) relationship was preserved. The basis for the corrections is discussed and the potential use of the equation in predicting fracture behavior in flawed cylinders from a knowledge of the fracture toughness or stress intensity factor is shown. (auth)

36105 EFFECT OF IRON-RICH INCLUSIONS ON THE FRACTURE CHARACTERISTICS OF ZIRCALOY: A METALLOGRAPHIC OBSERVATION. Ferrill, D. A.; Minassian, H. K. (Knolls Atomic Power Lab., Schenectady, N. Y.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 543-4(June 1969).

Examination of failed Zircaloy specimens under tension is discussed. Results of the examinations provide evidence that brittle iron-containing grain boundary inclusions crack early in tests in which the specimens are under strain. These cracks propagate into voids of considerable size and degrade material integrity, causing premature failure. (J.R.D.)

36106 MOLYBDENUM IN HOTWORKING TOOLS. PART 1. A COMPARISON WITH H-13. Burman, Russell W.; Braun, Horst (Climax Molybdenum Co., Ann Arbor, Mich.). Precis. Metal Molding, 26: No. 7, 61-2(July 1968).

TZM Mo (Mo + 0.5% Ti + 0.08% Zr) is compared with H-13 hot work steel as to its suitability for use in die casting dies. It is shown that TZM has a higher thermal conductivity, a lower coefficient of thermal expansion, greater resistance to thermal shock and about the same tensile strength and hardness. Creep strength, modulus of elasticity, stiffness, and corrosion resistance in molten metals are all also higher. No heat treatment is required for Mo alloys; they have excellent reuse capability and will machine and polish as readily as conventional steel tooling with the proper tools. (Metals Abstr.)

36107 THE INFLUENCE OF ALLOYING AUSTENITIC AND FERRITIC METAL ON ITS THERMAL BRITTLENESS. Ivanov, K. M.; Petrov, G. L. Svar. Proizv., No. 12, 1-3(Dec. 1968). (In Russian).

The effects of the amount of ferrite and of the alloying elements V, Si, Cr, Mo, and Nb on the thermal brittleness of Cr–Ni austenite-ferrite weld metal were investigated. Impact-strength values for various alloys are plotted against time up to 10,000 hr and ferrite content against time to 5000 hr at 425 to 700°C. Holding at 425°C does not result in significant embrittlement of the weld metal with ferrite contents up to 8 to 9%. Holding at 550 to 700°C results in significant embrittlement with ferrite contents of 4 to 9%. As the holding temperature and amount of ferrite are increased, embrittlement increases but the difference in the influence of the alloying elements decreases. Si has a powerful effect on thermal brittleness for the same ferrite content of 5 to 9%; Cr and Mo have a smaller effect and W and V still less. Ni when used to control the amount of ferrite reduces the impact strength sharply in the as-welded condition and this does not change much after aging. At 550 to 700°C embrittlement proceeds as a result of carbide formation. The carbide forming processes are then replaced gradually by σ-phase formation processes which leads to a further increase in embrittlement. The amount of carbide decreases on aging and the amount of σ-phase increases. There may be a close relationship between carbide dissociation processes and the formation of σ-phase nuclei. σ-phase nuclei are formed mainly by carbides of the $Me_{23}C_6$ type simultaneously with their dissociation. (Metals Abstr.)

36108 VAPOR PRESSURE AND CRYSTAL STRUCTURE OF CURIUM METAL. Smith, P. K.; Hale, W. H.; Thompson, M. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Chem. Phys., 50: 5066-76(June 15, 1969).

The vapor pressure of liquid and solid curium metal between 1179 and 2068°K between 10^{-10} atm and 0.1 mm was measured by the Knudsen effusion method to be $\log_{10} P(\text{atm}) = (4.74 \pm 0.37) - (18{,}060 \pm 590)/T(°K)$; $\Delta S^0_{1600°K}$ and $\Delta H^0_{1600°K}$ for vaporization are 82.6 ± 2.7 kcal/g·atm and 21.7 ± 1.7 eu, respectively. A previously unreported fcc close-packed structure for curium metal was identified with $a = 4.382 \pm 0.004$ Å, and a density of 19.26 g/cm^3, corresponding to a +4 metallic valence. The entropy of condensed curium is indicated to be relatively high by the low heat of fusion and by the $\Delta H^0_{298°K}$ for vaporization calculated by second- and third-law methods. The heat of vaporization of curium may be explained from the opposing effects of a quadrivalent metal and a $5f^6 6d^2 7s^2$ to $5f^7 6d 7s^2$ transition on vaporization. (auth)

36109 INTERNAL FRICTION OF IRON–CHROMIUM ALLOYS IN THE TEMPERATURE RANGE BETWEEN 20 AND 800°C. De Batist, R. (SCK-CEN, Mol, Belg.). J. Nucl. Mater., 31: 307-15(July 1969).

Internal friction of a number of iron-based alloys is measured between room temperature and 800°C. The exponentially rising damping observed above 500°C corresponds to an activation energy which is close to the energy for self-diffusion in iron. The grain boundary relaxation peak is observed around 620°C, in iron–chromium alloys, around 500°C in iron with oxide additions. For chromium-free specimens, the activation energy is found to be 2.5 eV. In iron–chromium alloys, large recovery effects which are observed between 500 and 800°C seem to be caused by processes governed by a wide spectrum of activation energies. (auth)

36110 DIFFUSION OF TITANIUM IN MODIFIED HASTELLOY N. Sessions, C. E.; Lundy, T. S. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 31: 316-22(July 1969).

Diffusion coefficients of ^{44}Ti in titanium-modified Hastelloy N have been determined from 800 to 1250°C by standard procedures involving serial sectioning by lathing or grinding and counting by gamma spectroscopy. The data were fitted to the Arrhenius expression $D = (15.3 \pm 2.2) \exp(-73{,}000 \pm 3300/RT)$ cm^2/sec. Results were used to predict the maximum loss by diffusion of titanium from the alloy in a typical molten-salt breeder reactor at 700°C. They are also compared with published diffusion data on similar systems. (auth)

36111 THERMAL EXPANSION OF SOME PLUTONIUM–GALLIUM SOLID SOLUTION ALLOYS. Taylor, J. M. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 31: 339-41(July 1969).

Thermal expansion properties were determined at 25 to 475°C for plutonium-gallium alloys. Alloys of Pu–1.39 at. % Ga, Pu–2.86 at. % Ga, and Pu–6.13 at. % Ga were produced by arc melting weighed amounts of plutonium and gallium on a water cooled copper hearth. Expansion curves were obtained for these alloys and empirical equations based on length change versus temperature were derived for each curve. (G.M.C.)

36112 CHEMICAL DIFFUSION IN THE SYSTEM IRON–MOLYBENUM. Pivot, J. P.; Van Craeynest, A.; Calais, D. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 31: 342-4(July 1969). (In French).

Molybdenum is one of the fission products most frequently found as a metallic inclusion in irradiated $(U,Pu)O_2$ fuels. Therefore, as a preliminary to the study of the diffusion of Mo in stainless steel cladding, a study of its diffusion in the iron–molybdenum system was undertaken. The method employed is that described by Jost (Diffusion in Solids, Liquids, Gases, Academic Press, New York, page 72, 1960). The phase diagram for the Fe–Mo system in the range of 0 to 50 at. % Mo is given. It was also verified by x-ray microanalysis that the kinetics of dissolution of the precipitates are not influenced by the diffusion. Formulas are given for relating the coefficient of diffusion, the solubility of molybdenum in iron, the concentration of the two phase alloy used, and the displacement of the interface zone with respect to the two phase–one phase system. Solubility increases rapidly with temperature and variations in the coefficient of chemical diffusion with concentration become important. (G.M.C.)

36113 SHORT-TERM TESTS PREDICT LONG-TERM CREEP-RUPTURE DATA. Muzyka, Donald R.; Whitney, Raymond C. (Carpenter Technology Corp., Reading, Pa.). Metal Progr., 96: 86-7(July 1969).

The excellent stability of Pyromet 860, a superalloy designed for the 1000 to 1500°F range, was confirmed by long-term (in excess of four years) stress-rupture tests. Samples of the alloy were prepared by two methods of heat treatment. One is designed for all-around strength and ductility, while the other, designed specifically for steam turbine bolting applications, gives optimum stress relaxation characteristics at 1050°F. Mechanical property data were obtained on hot rolled bars and forgings of a turbine wheel and blade. Pyromet 860 has good stress-rupture ductility as low as 1000°F. (G.M.C.)

36114 METHOD FOR DETECTING AND MEASURING DEFORMATIONS OF NUCLEAR FUEL ELEMENTS. (to Siemens-Schuckertwerke Aktiengesellschaft). French Patent 1,488,188. Filed Aug. 2, 1966.

A method is described for detecting and measuring deformations of nuclear fuel elements having a rectangular cross-section. This method comprises exploring the external faces of the element in the longitudinal direction by means of pistons each of which is movable in a cylinder and is subjected to the action of a hydraulic fluid and establishing the displacement of said pistons by means of a measuring cylinder. An apparatus for effecting the method is shown in detail in an accompanying drawing. (NPO)

36115 PROPERTIES OF SPHERICAL TUNGSTEN POWDER. Dubrovskii, A. P.; Mikhalev, V. I.; Petrunichev, V. A. Porosh. Met., Akad. Nauk Ukr. SSR, No. 6, 1-4(June 1969). (In Russian).

Properties of fine spherical tungsten powders are examined. Weight characteristics are given of both non-fractionated powder and separate narrow fractions. The chemical properties of the powder are determined. The behavior of the fine fractionated powders in pressing and sintering under different conditions are described. (auth)

36116 THERMODYNAMIC PROPERTIES OF URANIUM–ALUMINUM ALLOYS. Chiotti, P.; Kateley, J. A. (Ames Lab., Iowa). J. Nucl. Mater., 32: 135-45(Aug. 1969).

Emf measurements over the temperature range 400 to 840°C and calorimetric data were combined to develop thermodynamic relations for the reactions $U(s) + xAl(s) \rightarrow UAl_x(s)$. The relations obtained from emf measurements are $\Delta G^0(UAl_4) = -26{,}040 + 1.121T$, $\Delta G^0(UAl_3) = -25{,}190 + 0.487T$, $\Delta G^0(UAl_2) = -20{,}700 + 0.212T$. These relations are based on data obtained over the temperature spans of 401 to 639, 399 to 706, and 442 to 840°C, respectively. The standard deviations for the first and second terms (enthalpy and entropy of formation per mole of compound) are all within 140 to 160 cal/mole and 0.17 to 0.19 cal/mole·°K, respectively. The enthalpies of formation at 298°K as determined in an adiabatic calorimeter were -29.8 ± 2.0, -25.9 ± 2.0, and -22.1 ± 2.0 kcal/mole for UAl_4, UAl_3, and UAl_2, respectively. These data were combined with the emf data to yield the relations $\Delta G^0(UAl_4) = -32{,}040 - 7.52\ T \ln T + 59.07T$, $\Delta G^0(UAl_3) = -26{,}290 - 1.305T \ln T + 10.60T$, $\Delta G^0(UAl_2) = -22{,}790 - 2.326T \ln T + 18.37T$. The enthalpy change for the peritectic reaction at 732°C $UAl_4 \rightarrow UAl_3 +$ Al (in liquid solution) was determined to be 4.0 ± 0.4 kcal/mole. These data were employed in explaining the suppression of the formation of UAl_4 by the addition of ternary components which concentrate in the UAl_3 phase. (auth)

36117 EFFECT OF PRIOR DEFORMATION ON THE FRACTURE CHARACTERISTICS OF ZIRCONIUM–HYDROGEN ALLOYS. Beevers, C. J.; Warren, M. R. (Univ. of Birmingham, Eng.). J. Nucl. Mater., 32: 146-55(Aug. 1969).

Tensile tests at a strain rate of $\sim 5 \times 10^{-4}$/sec have been carried out on arc-melted iodide zirconium containing 50 ppM hydrogen. Specimens were initially deformed at –196, –110, and 20°C and subsequently taken to fracture at 20°C and –196°C, respectively. Prior deformation at 20°C resulted, at –196°C, in apparent yield discontinuities which can be directly related to the occurrence of a particular mode of hydride precipitate fracture. In general, prior deformation tended to improve the yield stress, fracture stress, and total strain to fracture. Where this prior deformation (–196°C) resulted in extensive hydride crack formation the improvement of the properties was limited, but they were never observed to be lower than those obtained from a straight through test at the final test temperature. (auth)

36118 TERMINAL SOLUBILITY OF HYDROGEN IN THE ZIRCONIUM/2 AT PERCENT CHROMIUM/0.16 AT PERCENT IRON ALLOY. Slattery, G. F. (United Kingdom Atomic Energy Authority, Lancs, Eng.). J. Nucl. Mater., 32: 30-8(Aug. 1969).

The terminal solid solubility (C_T) of hydrogen in zirconium/2 at. % chromium/0.16 at. % iron alloy has been determined in the temperature range 250 to 415°C using a dilatometric technique. The solubilities given by the heating curves are the equilibrium boundaries of the stable hydride phase and these were not significantly different from unalloyed zirconium or from the Zircaloys and zirconium/2½ wt % niobium alloy. The terminal solid solubility for the cold-worked Zr/2 at. % Cr/0.16 at. % Fe alloy was given by $C_T = 9.26 \times 10^5 \exp(-11{,}120/RT)$ ppM and for the heat-treated alloy by $C_T = 6.22 \times 10^5 \exp(-10{,}570/RT)$ ppM. The values of hydrogen solubility were both very similar. (auth)

36119 THERMAL AND ELECTRIC CONDUCTIVITY OF VANADIUM ALLOYS BETWEEN 20 AND 650°C. Heubner, U. (Metall-Laboratorium der Metallgesellschaft AG, Frankfurt am Main). J. Nucl. Mater., 32: 88-100(Aug. 1969). (In German).

Measurements were made of the thermal and electric conductivity of vanadium–titanium and vanadium–titanium–niobium alloys containing up to 20 wt % titanium or niobium. Both for pure vanadium and for the alloys the thermal conductivity increases with temperature in the range 20 to 650°C. The temperature-dependence of the electric conductivity diminishes with increasing titanium content, while the influence of niobium on the thermal and electric conductivity is relatively small at 20°C and becomes even smaller as the temperature rises. The specific electric resistivity follows an exponential function of increase between 20 and 800°C; the function is similar for all the alloys investigated. The only alloys which show anomalous behavior are V/3% Ti and V/3% Ti/15% Nb, the latter to a lesser degree. Apart from the alloy V/3% Ti, the thermal conductivity of all the alloys investigated rises proportionately to the function T/ρ. The thermal conductivity can be computed from the electric resistivity, with sufficient accuracy, over the entire temperature range between 20 and 650°C. Values of thermal conductivity at higher temperatures can also be computed from values of electric resistivity measured at 20°C. With respect to thermal conductivity, these vanadium alloys are superior or at least equivalent to heat-resistant steels and nickel alloys at high temperatures. (auth)

36120 PARTIAL MOLAR ENTHALPIES OF SOLUTION FOR TUNGSTEN AND TANTALUM IN LIQUID RARE-EARTH METALS. Bowersox, D. F. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 32: 161-4(Aug. 1969).

Data on solubilities of W and Ta in rare earths are used to calculate partial molar enthalpies of solution using regular solution theories. Average values are presented tabularly. The solubility order which increases from Yb to Sc is similar for the two solutes and in each solute pair W is less soluble than Ta. Data are also included on the cohesive densities of liquid rare earth elements. (J.R.D.)

36121 TORSIONAL DUCTILITY AND STRENGTH PROPERTIES OF TWO Pu/1 WT PERCENT Ga DELTA STABILIZED ALLOYS AS A FUNCTION OF TEMPERATURE. Wheeler, A. D.; Robbins, J. L. (Univ. of California, Livermore). J. Nucl. Mater., 32: 57-72(Aug. 1969).

The torsional ductility and strength characteristics of two Pu/1 wt % Ga alloys—one of nominal purity and the other of high purity—were evaluated at 20 to 600°C at a torsional strain rate of 0.0417/sec. As the temperature is increased over the range of 20 to 150°C, ductility is slightly increased. In this region the high-purity alloy shows greater ductility than the nominal-purity alloy. Ductility increases rapidly between 150 and 250°C for both materials, leading to increased ductility for the nominal-purity alloy

between 200 and 400°C and between 500 and 580°C. The high-purity alloy exhibits the same increased ductility between 250 and 500°C and above 560°C, but shows an anomalous drop in ductility at 560°C. In these increased ductility regions, both materials survive true shear strains of 250 without fracture. This high capacity for deformation is associated with a dynamic restoration process which leads to a very fine-grained (1 to 5 μm grain diameter) equiaxed structure at room temperature. The mechanism of this process is currently thought to be concomitant recrystallization. The nominal-purity alloy exhibits a typically brittle type of failure (helical fracture) between 400 and 500°C; this "hot short" behavior is a result of the formation of a Pu/Pu_6Fe liquid eutectic, possibly at the grain boundaries. The torsional yield stress for both materials decreases continuously with increasing temperature between 20 and 560°C. Above 350°C, the yield stress of the high-purity alloy is somewhat higher than that of the nominal-purity alloy; this behavior may be associated, at least in part, with the higher tantalum and tungsten contents of the high-purity alloy. The nominal-purity alloy shows no significant loss of strength in the "hot short" region between 400 and 500°C. For the nominal-purity alloy, the conversion of torsional yield strength to tensile yield strength by means of the effective stress criterion produces a curve of equivalent 0.2% offset yield strength versus temperature which agrees fairly well with previously published data on tensile strength versus temperature for a similar material tested at a comparable strain rate. (auth)

Structure and Phase Studies

Refer also to abstracts 35381, 36022, 36054, 36085, 36102, 36103, 36148, 36151, 36154, 36158, 36160–36162, and 36265.

36122 (AFML-TR-65-2(Pt.5)) TERNARY PHASE EQUILIBRIA IN TRANSITION METAL–BORON–CARBON–SILICON SYSTEMS. PART V. COMPENDIUM OF PHASE DIAGRAM DATA. Rudy, E. (Aerojet-General Corp., Sacramento, Calif. Materials Research Lab.). May 1969. Contract AF33(615)-1249. 731p.

Systems studied include binary transition metal systems, binary and ternary systems of refractory transition metals with carbon, boron, nitrogen, and silicon, and selected concentration-temperature sections of higher order systems involving the same elements. (J.C.W.)

36123 (AWRE-O-21/69) DUCTILE–BRITTLE TRANSITION OF URANIUM. Hughes, A. N.; Orman, S.; Picton, G.; Thorne, M. A. (Atomic Weapons Research Establishment, Aldermaston (England)). Mar. 1969. 19p. Dep. CFSTI. UK 4s. 0d.

The mechanical properties of uranium have been studied at −75 to 175°C for four different heat treated conditions of the metal. The elongation and reduction in area-temperature curves are coincident or have identical shapes for 3 of the heat treated conditions, all showing a maximum at about 100°C. Alpha annealed material shows a maximum on the elongation-temperature curve at a slightly higher temperature but the reduction in area increases with temperature over the whole range investigated. In all cases the UTS falls rapidly below room temperature, but this is shown to result from uranium-water interaction. The possible mechanisms for this embrittlement are discussed. (auth)

36124 (GEPP-60) QUANTITATIVE MEASUREMENT OF PREFERRED ORIENTATION IN METAL FILMS. Biver, C. J. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). May 14, 1969. Contract AT(29-2)-656. 11p. Dep. CFSTI.

The quantitative measurement of preferred orientation in thick (>5000 Å) metal films may be expressed as an inverse pole figure. An expression for the percentage of film volume with a particular (hkl) plane oriented parallel to the metal film surface is derived. This formulation is expressed in terms relative to a randomly oriented sample, which means that the preferred orientation of metal films may be expressed in numerical form. (auth)

36125 X-RAY ANALYSIS OF ALUMINIUM-RICH TERNARY ALLOYS OF ALUMINIUM AND RARE-EARTH METALS OF THE YTTRIUM SUBGROUP AND SCANDIUM. Zaluts'ka, O. I.; Ryabov, V. R.; Zaluts'kii, I. I. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 3, 255-9(Mar. 1969). (In Ukrainian).

By means of the x-ray powder analysis the Al-rich alloys of 15 ternary systems R−R′−Al were investigated. The isothermic section (at 500°C) of the region $Al-RAl_3-R'Al_3$ was determined for each system. The crystal structures of the ternary compounds $(R,R')Al_3$ are intermediate (in respect to the content of hexagonal and cubic symmetry) between the structures of the binary compounds RAl_3 and $R'Al_3$. (auth)

36126 COMPOUNDS OF THE Cr_3B_2 AND Mn_5Si_3 TYPES IN THE RARE-EARTH METAL–GALLIUM SYSTEMS. Dzyana, D. I.; Krip'yakevich, P. I. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 3, 247-50(Mar. 1969). (In Ukrainian).

By means of x-ray diffraction analysis of the powder the existence of the compounds R_5Ga_3 was established. The compounds of La, Nd, Sm, Gd, Tb, Dy belong to the Cr_5B_3 type, the compounds of Ho, Er, Tu, Lu—to the Mn_5Si_3 type. (auth)

36127 TRACER DIFFUSION IN TUNGSTEN. Pawel, R. E.; Lundy, T. S. (Oak Ridge National Lab., Tenn.). Acta Met., 17: 979-88(Aug. 1969).

Measurements of the lattice diffusion coefficients for Nb, Ta, and W isotopes in tungsten were made at 1300 to 2400°C using standard tracer methods in combination with anodic-film sectioning techniques. The data indicated that the Arrhenius relation was obeyed over the entire temperature range, and the following analytical expressions were obtained. $D(Nb) = 3.01 \exp(-137{,}600/RT)$ cm^2/sec, $D(Ta) = 3.05 \exp(-139{,}900/RT)$ cm^2/sec, and $D(W) = 1.88 \exp(-140{,}300/RT)$ cm^2/sec. The characteristics exhibited by the penetration profiles of both single- and polycrystalline specimens emphasized the need for sensitivity and completeness in the data used for the determination of both lattice and short-circuit diffusion parameters. When measuring lattice diffusion coefficients, even in single crystals, it was found that the section thickness must be kept smaller than $\sqrt{(Dt)}$ to minimize the effects of short-circuit paths. Conversely, in the region of the profile governed by short-circuit effects, extensive sets of data could not be described in terms of a simple model leading to a unique diffusion coefficient. (auth)

36128 HEAT OF SOLUTION AND DIFFUSIVITY OF NITROGEN IN MOLYBDENUM. Evans, J. H.; Eyre, B. L. (Atomic Energy Research Establishment, Harwell, Eng.). Acta Met., 17: 1109-15(Aug. 1969).

A study has been made of the solubility and diffusivity of nitrogen in high purity zone refined molybdenum (resistivity ratio ~6000) making use of liquid helium resistivity measurements to monitor the presence of the gas. The nitrogen was retained in supersaturated solution in the molybdenum by quenching specimens in mercury after heating at high temperatures in a nitrogen atmosphere. The heat of solution was then found by measuring the quenched-in resistivity as a function of quench temperature in the range 1400 to 2200°C. The value over this range was calculated to be 0.80 ± 0.01 eV. By varying the nitrogen pressure it was confirmed that Sieverts $p^{\frac{1}{2}}$ law is obeyed. The diffusivity was determined at temperatures in the range 1500 to 2000°C from evolution curves representing the rate of loss of nitrogen from the specimens when heated in vacuum. The results show that the diffusivity of nitrogen in molybdenum obeys the equation $D = 3.0 \cdot 10^{-3} \exp(-1.2\ eV/kT)$ cm^2/sec. (auth)

36129 DIAGRAM OF PHASE EQUILIBRIA OF THE SYSTEM HAFNIUM–MANGANESE. Shurin, A. K.; Dmitrieva, G. P. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 1, 67-9(Jan. 1969). (In Ukrainian).

A complete diagram of the system hafnium–manganese state is plotted by the methods of differential thermal, metallographic, roentgenostructural, and dilatometric analyses of cast and annealed alloys. The existence of two intermetallic compounds $HfMn_2$ and Hf_3Mn_2 is established in the system, and conditions of their formation are determined. The manganese solubility limit is shown in a solid solution on the hafnium base. (auth)

36130 CHARACTERISTIC TEMPERATURE, YOUNG'S MODULUS, ROOT-MEAN-SQUARE ATOMIC DISPLACEMENT IN LATTICE OF TITANIUM, VANADIUM, CHROMIUM, IRON, COBALT, AND ZIRCONIUM BORIDES. Frantsevich, I. M.; Lyashchenko, A. B. (Inst. of Problems in Material Studies, Erevan). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 1, 64-6(Jan. 1969). (In Ukrainian).

Experimental values of Young's modulus were obtained for titanium, vanadium, chromium, iron, cobalt and zirconium borides. On the basis of these data, characteristic temperatures and root-mean-square atomic displacement are calculated in the lattice of these borides. (auth)

36131 DIAGRAM OF THE SYSTEM CHROMIUM–NEODYMIUM STATES. Svechnikov, V. M.; Kobzenko, G. F.; Martinchuk, E. L.; Vanchenko, V. G. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 1, 61-4(Jan. 1969). (In Ukrainian).

A diagram of states is plotted for the first time by the data of differential thermal, roentgenostructural, durometric, and metallographic analyses of cast and annealed alloys. (auth)

36132 INVESTIGATION OF Zr–Co–Al SYSTEM. Burnashova, V. V.; Markiv, V. Ya. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 1, 59-61(Jan. 1969). (In Ukrainian).

The system Zr–Co–Al was investigated by means of x-ray and microstructural analyses. The phase equilibria were determined at 900°C and the existence of three ternary compounds was established including Zr_6CoAl_2, $\sim Zr_6Co_7Al_{16}$, and $\sim ZrCoAl_4$. The investigation of the powders and single crystals of these compounds resulted in the structure of Zr_6CoAl_2 — hexagonal, a = 7.93 Å, c = 3.31 Å, c/a = 0.42; space group D_{6}^{4}–$P6_322$, N = 9; $\sim Zr_6Co_7Al_{16}$ has the Th_6Mn_{23} type structure (a = 12, 17 Å); the structure of $ZrCoAl_4$ — hexagonal, a = 7.26 Å, c = 9.09 Å, c/a = 1.25, space group D_{6}^{4}–$P6_322$, N ≈ 26. (auth)

36133 INVESTIGATIONS ON THE STABILIZATION OF UAl_3 IN ALUMINIUM-RICH NUCLEAR FUEL. Exner, H. E.; Petzow, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Metall, 23: 220-5(Mar. 1969). (In German).

Methods of increasing the stability of the UAl_3 phase in Al-U alloys, in preference to the brittle UAl_4 phase, are discussed. Addition of other components, such as Zr and Ni are considered. It is shown that in these 3-component systems the UAl_3 phase is in thermodynamic equilibrium with the aluminum matrix. (M.C.G.)

36134 INTERMETALLIC PHASES AND PRECIPITATION OF CARBIDES IN COBALT-BASE SURFACING ALLOYS. Loebl, K. Strojirenstvi, 18: 214-25(Mar. 1968). (In Czech).

The structure and properties of Co-base surfacing alloys are described. The slowest rate for carbide precipitation was observed for alloys containing Cr and other carbide-forming elements (W and Mo). Factors influencing structure formation, and the relation between structure and properties of built-up layers, are analyzed. The max rate of carbide precipitation was found at 750°C. (Metals Abstr.)

36135 EFFECT OF HAFNIUM ON THE STRUCTURE OF MOLYBDENUM–CARBON ALLOYS IN THE CAST STATE. Geveling, N. N.; Kantor, M. M.; Chekreneva, I. V. Fiz. Khim. Obrab. Mater., No. 1, 70-9(Jan.-Feb. 1969). (In Russian).

The structure of a number of Mo–Hf–C castings was studied and the results were interpreted in terms of the effect of Hf on the interaction between Mo and C. The introduction of Hf into Mo–C alloys greatly reduces the grain size, particularly in the case of alloys with a high C content. This effect is partly attributable to the precipitation of HfC phase, and is also in accordance with the morphological characteristics of the carbides (HfC and Mo_2C). The formation of acicular HfC inclusions within the grains tends to free the grain boundaries from Mo_2C particles. (Metals Abstr.)

36136 INFLUENCE OF Ag AND Ge-ADDITIONS ON THE THETA-PRIME PRECIPITATION IN AN AlCuCd-ALLOY. Nuyten, J. B. M. Scr. Met., 2: 441-2(Aug. 1968).

From a study of the effect of small additions of Cd (0.02 at. %) on precipitation of the intermediate phase, θ', in an Al–1.7 at. % Cu alloy, it is concluded that the presence of Cd vacancy complexes results in a much higher θ' precipitation rate in the ternary Al–Cu–Cd alloy than in the binary Al–Cu alloy. Further additions of Ag, which is rather soluble in Cd, or forms intermetallic compounds with Cd, reduce the number of Cd-vacancy complexes and lower the precipitation rate. Additions of Ge, which is virtually insoluble in Cd, do not interact with Cd-vacancy complexes and therefore do not alter the θ' precipitation in the alloy. (Metals Abstr.)

36137 TERNARY URANIUM ALLOYS. (to Comitato Nazionale per l'Energia Nucleare). French Patent 1,454,421. Filed May 21, 1965.

Ternary uranium alloys are described which have a fine grain structure after casting. The alloy contains 0.1 to 0.3 wt % of Mo and 0.6 to 0.8 wt % of Nb or 0.5 wt % of Mo and 0.3 wt % of Nb or 0.2 to 0.4 wt % of Mo and 1.5 to 2.2 wt % of Zr, the remainder consisting of U and unavoidable impurities. The grains of the alloys are refined by a heat treatment which comprises heating the alloys at a temperature of 900°C and then continuously cooling at the rate of 5 to 60°C per minute. Preferably the grain size ranges from 100 to 175 μ prior to the heat treatment, the grain size after the heat treatment ranging from 20 to 100 μ depending on the cooling rate. (NPO)

36138 STRUCTURE OF METALS AND ALLOYS, 5TH EDITION. Hume-Rothery, W.; Smallman, R. E.; Haworth, C. W. Monograph and Report Series No. 1. London, Institute of Metals and Institution of Metallurgists, 1969. 407p. 70s.

The following topics are discussed: Electronic background to metallurgy; crystal structures of the elements; atomic radii and physical properties of the elements; terminal solid solutions; intermediate phases in alloy systems; and imperfections in crystals. (UK)

36139 DIAGRAM OF STATES OF THE SYSTEM CHROMIUM–CERIUM. Svechnikov, V. M.; Kobzenko, G. F.; Ivanchenko, V. G.; Martinchuk, E. L. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 4, 354-6(Apr. 1969). (In Ukrainian).

The diagram of states is plotted by the data of differential thermal, x-ray crystal, and metallographic analyses, as well as by the results of measuring microhardness carried out in cast and annealed alloys. (auth)

36140 INVESTIGATION OF THE Zr–Fe–Al SYSTEM. Burnashova, V. V.; Markiv, V. Ya. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 4, 351-3(Apr. 1969). (In Ukrainian).

The system Zr–Fe–Al was investigated by means of x-ray and microscopic analyses. The phase equilibria were determined and the existence of two ternary compounds Zr_6FeAl_2 and $ZrFe_{7-4}Al_{5-8}$ was established. On the basis of single-crystal investigation of the compound Zr_6FeAl_2, the data obtained included Zr_6FeAl_2-hexagonal lattice; a = 7.94 Å, c = 3.32 Å, c/a = 0.42, space group is D_{6}^{4}–$P6_322$, N = 9. The compound $ZrFe_{7-4}Al_{5-8}$ has a crystal structure of the $ThMn_{12}$ type (a = 8.49$_3$ to 8.59$_5$ Å, c = 4.88$_9$ to 4.96$_7$ Å, c/a = 0.58). (auth)

36141 PROTON SCATTERING AS A TOOL FOR THE STUDY OF CRYSTAL STRUCTURES. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). pp 191-7 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.

See CONF-680401.

The regular nature of the crystal lattice has a marked influence on the trajectories of protons traveling through crystalline solids, and on the spatial distribution of protons elastically scattered from their surfaces. The periodic potentials existing within the crystal cause the protons to undergo correlated collisions with the lattice atoms, so that their trajectories are steered either along or away from certain well-defined crystallographic directions. Such steering effects have been termed "channelling" and "blocking," respectively. A new technique is described, based on these phenomena, which can be usefully employed to study both the structure of crystals and the atomic positions of impurity atoms within crystals. (auth)

36142 STUDY OF THE STRUCTURAL TRANSFORMATIONS IN THE ZIRCONIUM–NIOBIUM ALLOY CONTAINING 8 WT PERCENT Nb. Van Effenterre, P.; Cizeron, G.; Lacombe, P. (Laboratoire de Metallurgie, Orsay, France. Centre d'Etudes Nucleaires, Saclay, France). J. Nucl. Mater., 31: 269-78(July 1969). (In French).

In a zirconium-niobium alloy containing 8 wt % Nb, the body-centered β phase, stable at high temperature, can be partially preserved at room temperature. This phase then coexists with ω phase of hexagonal structure and/or with close packed hexagonal α phase. The various transformations were studied in the course of isothermal or anisothermal heat treatments, using principally x-ray diffraction, dilatometry, micrographic methods, and DTA. TTT and other kinetic diagrams were deduced from the results and their interpretations discussed. The transformation of this 8%-niobium alloy is compared with the behavior of zirconium alloys containing higher niobium contents, and also with the behavior of similar alloys, especially those based on titanium. (auth)

36143 ALLOY CHEMISTRY OF $\sigma(\beta$–U)-RELATED PHASES. II. THE CHARACTERISTICS OF δ AND OTHER σ-RELATED PHASES IN SOME Mo–NiX SYSTEMS. Virkar, Anil V.; Raman, Aravamudhan (Louisiana State Univ., Baton Rough). Z. Metallk., 60: 594-600(July 1969).

The δ-phase occurs in the alloy $Mo_{53}Ni_{47}$ and possesses a homogeneity range of about 2 at. %. With increasing Ni-content, the lattice parameters and the cell volume decrease, σ-related phases, R, μ, and $MgZn_2$-type Laves phase, occur only in Mo–Ni–Si and have broad regions of homogeneity. A $MgCu_2$-type Laves phase (a = 6.906 Å) is formed when small amounts, about 2 at. %, of Mo substitute for Ni in $ZrNi_2$. A ternary Ti_2Ni-type phase (a = 12.34 Å) occurs at the middle of the Zr_2Ni–Zr_2Mo section. The occurrence of the σ-related phases in the Mo–Ni–X systems is interpreted in terms of the valence (bonding) electron concentrations. (auth)

36144 REACTION OF PLUTONIUM WITH ADDITION ELEMENTS FROM GROUPS III AND IVB OF THE PERIODIC TABLE IN MAGNESIUM ALLOY. Mouchnino, M.; Priol, C. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 32: 39-45(Aug. 1969). (In French).

The effects of addition elements (X) on the diffusion of plutonium in Mg-X alloys has been studied. This study was done on diffusion couples consisting of Mg-Pu/Mg-X, where X is one of the elements of groups III B or IV B of the periodic table. Aluminum, gallium, silicon, germanium, tin, and lead trap the plutonium in the form of intermetallic compounds $PuAl_2$, $PuGa_2$, $PuSi_2$ (Pu, Ge) Mg_2, $PuSn_3$, $PuPb_3$. These compounds were identified by microanalysis and x rays. (auth)

Radiation Effects

Refer also to abstracts 35362, 36064, 37458, 37542, and 37543.

36145 (JUL-577-FN) DEFECT PRODUCTION AND RECOVERY BY LOW-TEMPERATURE ELECTRON RADIATION OF PLATINUM. Duesing, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik). Feb. 1969. 76p. (In German). Dep.

Platinum was irradiated with electrons at 4.5°K. Defect structure and thermal recovery of the defects were investigated by measurement of the electrical resistance. In irradiation with 3-MeV electrons up to doses of 3×10^{19} cm^{-2} a decrease of the defect production rate was observed with increasing dose. This saturation effect was analyzed by subthreshold irradiation with 1.4-MeV electrons and by radiation doping experiments. It was established that spontaneous recombination and recombinations by subthreshold collision effects control the defect structure to the same degree. Reaction volume or effective cross sections for this process was determined. The defects recombined by subthreshold collisions are almost exclusively neighboring Frenkel pairs. Introduction of vacancies by quenching before irradiation increases the number of spontaneous recombinations and increases the damage rate at low defect concentrations by deviation from the Matthiessen rule. The defects produced were recovered by isochronous temperature program. The substructure of stage I was decomposed with increasing irradiation damage, especially the stage $I_D - I_E$ decreases sharply with increasing damage. Stage II was increased with increasing damage. With approximation of the damage to saturation, stage II was independent on the impurities and assumes the formation of greater interstitial lattice atom agglomerates in $I_D - I_E$. After high damage the observed recovery equals the recovery after neutron irradiation with smaller doses. The controlling high temperature stage was observed between 500 and 700°K. It is dose-dependent. Material quenched before the irradiation shows an additional stage at higher temperatures. It was proposed to characterize these two stages as stage III and to assign a room temperature stage observed after slight damage to stage II. (tr-auth)

36146 HYDROSTATIC PRESSURE INDUCED RECOVERY OF LATTICE PARAMETER INCREASES IN NEUTRON IRRADIATED MOLYBDENUM. Kulcinski, G. L.; Kissinger, H. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Acta Met., 17: 1117-21(Aug. 1969).

Neutron irradiation of high purity molybdenum to 6.2×10^{18} n/cm^2 ($E > 1$ MeV) at 40°C results in a 0.022% lattice parameter increase. Isochronal anneals at pressure below 1 bar disclose that the lattice expansion of the material recovers in three stages, 150, 400, and 750°C. Combination of this data with previously obtained electric resistance measurements reveals that there are at least four recovery stages in Mo above room temperature. The designation of recovery stages has been modified: stage III (150°C), stage IV-A (400 to 425°C), stage IV-B (575°C), and stage V (750°C). The application of 20,000 bars of hydrostatic pressure during isochronal annealing lowers stage III to 90°C indicative of a negative activation volume of migration. The temperature for stage V recovery of the lattice parameter increase is lowered by pressure from 750 to 350°C. (auth)

36147 THE INFLUENCE OF RADIATION DAMAGE ON THE TRAPPING OF LOW-ENERGY He^+ IONS IN TUNGSTEN. Erents, K.; Farrell, G.; Carter, G. (Univ. of Liverpool). pp 145-8 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.

See CONF-680401.

The trapping of 160-eV He^+ ions in polycrystalline tungsten was studied after prebombardment of the tungsten with energetic Ne, Ar and Kr ions. It was found that prebombardment enhances the probability of He entrapment, owing to the production of damage in which the He can be trapped. (auth)

36148 SWELLING OF FUEL CLADDING ALLOYS DURING FAST-NEUTRON IRRADIATION. Wolff, U. E. (General Electric Co., Pleasanton, Calif.); Withop, A.; Lauritzen, T. A. Trans. Amer. Nucl. Soc., 12: 114-15(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36149 DAMAGE FUNCTIONS AND DATA CORRELATION. McElroy, W. N. (Battelle-Northwest, Richland, Wash.); Dahl, R. E. Jr.; Serpan, C. Z. Jr. Trans. Amer. Nucl. Soc., 12: 138-9 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36150 POSTIRRADIATION CREEP-RUPTURE PROPERTIES OF AISI TYPE-304 STAINLESS STEEL. Lovell, A. J. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 127-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36151 GRAIN-BOUNDARY CARBIDES AND POSTIRRADIATION TENSILE PROPERTIES OF TYPE-304 STAINLESS. Withop, A. (General Electric Co., Sunnyvale, Calif.); Wolff, U. E.; Busboom, H. J. Trans. Amer. Nucl. Soc., 12: 128-9 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36152 IRRADIATION DAMAGE TO ANNEALED TYPE-316 STAINLESS STEEL. Bloom, E. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 129-30(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36153 EFFECTS OF HELIUM ON BIAXIAL CREEP-RUPTURE OF STAINLESS STEEL IN SODIUM. Mahoney, M. W.; Shively, J. H. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 130(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36154 EFFECT OF IRRADIATION ON THE ELEVATED-TEMPERATURE FRACTURE OF SELECTED FACE-CENTERED CUBIC ALLOYS. Kangilaski, M.; Peterson, S. L.; Perrin, J. S.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 130-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36155 STRESS DEPENDENCE OF THE IN-REACTOR UNIAXIAL CREEP OF Zr-2 AND Zr-2.5 Nb. Gilbert, E. R.; Mastel, B. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 132-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36156 SOME CONSIDERATIONS OF RADIATION-ENHANCED CREEP. Tesk, J. A.; Li, C. Y. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 133(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36157 EFFECT OF VOID-INTERSTITIAL LOOP INTERACTIONS ON IRRADIATION-PRODUCED SWELLING. Straalsund, J. L.; Holmes, J. J. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 115-16(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36158 COMPARISON OF DEFECT STRUCTURES IN NICKEL AND STAINLESS STEEL AFTER IRRADIATION AT INTERMEDIATE TEMPERATURES. Bloom, E. E.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 116-17(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36159 IRRADIATION-INDUCED SWELLING IN NICKEL ALLOYS. Holmes, J. J. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 117-18(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36160 IRRADIATION-INDUCED PRECIPITATION IN TYPE-316 STAINLESS STEEL. Brager, H. R.; Kissinger, H. E. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 118(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36161 IRRADIATION DAMAGE IN VANADIUM AT 600°C. Wiffen, F. W.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 119-20(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36162 VOID FORMATION IN FAST-NEUTRON IRRADIATED TYPE-304 STAINLESS STEEL. Harkness, S. D.; Letzring, D.; Li, C. Y. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 115(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36163 EFFECT OF VOID VOLUME ON THE IRRADIATION PERFORMANCE OF ALUMINUM-BASE DISPERSION-TYPE FUEL PLATES. Martin, M. M.; Richt, A. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 98-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36164 FISSION-GAS RELEASE AND THERMAL CONDUCTIVITY MEASUREMENTS ON U-5 WT. PERCENT Fs IRRADIATED IN CP-5. Beck, W. N.; Fousek, R. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 78-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36165 NOTE ON THE APPLICATION OF HOMOGENEOUS NUCLEATION THEORY TO BUBBLE NUCLEATION IN URANIUM METAL. Harrison, J. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Nucl. Mater., 31: 327-9(July 1969).

Using relevant values of observed gas diffusion coefficients in uranium, agreement is obtained between calculated and observed gas bubble densities in irradiated uranium. (auth)

36166 HIGH TEMPERATURE EMBRITTLEMENT OF AUSTENITIC Cr-Ni STEELS BY NEUTRON IRRADIATION. Reinhard, Wolfgang (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Neue Huette, 14: 75-9(Feb. 1969). (In German).

A critical evaluation is made of the international data available on the neutron-induced high temperature embrittlement of austenitic Cr-Ni steels. The mechanical properties of some austenitic steels after irradiation are reviewed. The initial processes in the embrittlement are described. The effect of hydrogen and the material state on the embrittlement is discussed. (J.S.R.)

36167 RECOVERY OF DAMAGE IN NEUTRON-IRRADIATED A-286. Keys, L. K.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati). J. Nucl. Mater., 32: 165-7(Aug. 1969).

An isochronal resistivity study after neutron irradiation has been performed on a split heat of an austenitic steel, 15Cr-25Ni-Ti-Al (A-286), containing two concentrations of natural boron (10 and 100 ppM by weight) designated heats A and C, respectively. This alloy has been considered for possible use in high strength structural components in nuclear reactors. Both the heats were thermally treated at 900°C, oil quenched for 2 hr at 720°C, air cooled, reheated to 650°, and air cooled. The specimens were 0.318 cm diameter by 5.08 cm long rods and were irradiated to a fast neutron fluence ($E_n \geq 1$ MeV) of 4.6×10^{19} n/cm^2 and a thermal neutron fluence of 6.5×10^{20} n/cm^2 at approximately 70°C. The results indicate that the contributions to the irradiation induced resistivity increase arise primarily from the fast neutron ($E_n \geq 1$ MeV) damage rather than from helium formation from the $^{10}B(n,\alpha)^7Li$ thermal neutron reaction. Data on annealing recovery of the alloy in terms of isochronal resistivity changes are included. (J.R.D.)

36168 DRIVING FORCES FOR PORE GROWTH AND SWELLING DURING IRRADIATION. Gulden, T. D.; Kaae, J. L. (Gulf General Atomic Inc., San Diego, Calif.). J. Nucl. Mater., 32: 168-70(Aug. 1969).

Information in support of a suggestion that the chemical stress associated with radioinduced vacancy and interstitial supersaturations in alpha uranium may be as important in void growth during irradiation as mechanical stress is given. It is concluded that, in general, both chemical and mechanical stresses should be considered as driving forces for void growth during irradiation. (J.R.D.)

36169 INTERACTION OF FINITE GAS BUBBLES IN A SOLID. Willis, J. R.; Bullough, R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 32: 76-87(Aug. 1969).

The accurate elastic interaction between two finite gas bubbles, each of arbitrary size and excess gas pressures, is obtained. It is found that two such bubbles always attract one another in an elastically isotropic medium and the magnitude of the attraction is very large when the bubble separation is small. The significance of this attraction is discussed in relation to the swelling in nuclear fuels. (auth)

36170 SOME PROPERTIES OF A URANIUM ALLOY SHOWING BOTH A HIGH RESISTANCE TO CREEP AND SLIGHT SWELLING UNDER IRRADIATION. Blanchard, P.; Azam, N.; Virot, A. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). J. Nucl. Mater., 32: 113-19(Aug. 1969). (In French).

An account is presented of attempts to improve the creep resistance and resistance to swelling of the industrial nuclear fuel alloy U/1.1% Mo without appreciably altering methods of fabrication. It appears that it is possible to achieve the desired result by adding 500 ppM aluminum and 500 ppM tin. Hypotheses are advanced to take into account the two vital properties of this new alloy — good creep resistance and small swelling under irradiation — properties which until now have been considered difficult to reconcile. (auth)

Ceramics and Cermets

Refer also to abstracts 35059, 35392, 35980, 35982, 35983, 35986, and 35988.

36171 (BMI-1864) PROGRESS ON HIGH-TEMPERATURE FUELS TECHNOLOGY DURING FEBRUARY-APRIL 1969. Quarterly Report, Task 6. Keller, Donald L.; Chubb, Walston (Battelle Memorial Inst., Columbus, Ohio). May 1969. Contract W-7405-eng-92. 92p. Dep. CFSTI.

A pronounced columnar grain structure accompanied by lenticular voids has been observed in UN specimens irradiated at surface temperatures over 1750°C. This structure is similar to that found in UO_2 and UO_2-PuO_2 specimens at similar temperatures in irradiations. UC does not develop columnar grains or lenticular voids under these conditions. Since both UO_2 and UN show high degrees of gas release under these conditions, whereas UC shows a lower degree, it appears that the evaporation of UN and UO_2 from regions containing fission products and the condensation of purer UN and UO_2 on the top surfaces of columnar grains is a major step in the process of collection and release of fission gases from UO_2 and UN. Data on the steady-state evaporation rates of refractory fuels show that at 2000°K the evaporation rates of UC are much lower than those of UO_2 and UN. These data provide a physical basis for the proposed mechanism of zone purification of UO_2 and UN by lenticular void movement during irradiations. A tendency for UN specimens to decompose to nitrogen gas and uranium metal during irradiations has been tentatively associated with surface temperatures over 1640°C and with loss of the gas tightness of claddings at diametral expansions near and above 5 percent. An 80 percent dense UC-ZrC specimen released 70 percent of its fission gas during an irradiation to a burnup of 1.9×10^{20} fissions per cm^3 at temperatures between 1600 and 1820°C. The porosity of this specimen increased to about 36 percent at the end of the irradiation. In an earlier irradiation under similar conditions, a dense UC specimen was found to have released only 42 percent of its fission gas even though the external dimensions indicated a volume increase of 34 percent. Initial porosity has clearly accelerated gas release and reduced external swelling. A tentative evaluation of the gas pressures monitored inside the cladding of a UO_2 specimen being irradiated at a surface temperature of 1890°C suggests that the gas generated in this specimen is released essentially instantaneously. No burst of gas release was observed as a result of reactor shutdown and startup, in agreement with the pressure data which suggest that no gas is stored in the fuel. The preliminary results of a fission-gas-bubble re-solution experiment suggest that an exposure of about 2×10^{15} fissions per cm^3 is sufficient to redissolve all the fission-gas-bubble nuclei produced by an initial exposure to 1.5×10^{16} fissions per cm^3 followed by an anneal of 24 hr at 1600°C to form bubble nuclei. Studies of phase equilibria at 1550°C show that UC can be expected to react with vanadium to form a uranium-base liquid plus V_2C at this temperature; however, a quasi-binary exists between UN and vanadium metal at 1550°C, so that no new phases should form between these two materials. (auth)

36172 (EUR-4190) PROBLEMS OF THE PEBBLE BED AND GRANULAR MATERIALS. Proceedings [of] THTR Symposium, Juelich, Germany, March 6-7, 1968. Bedenig, D. (ed.) (European Atomic Energy Community, Brussels (Belgium). Center for Information and Documentation). 1968. 637p. (In German and English). (CONF-680327). FB 500,-; DM 40,-; FF 50,-; Lit 6,250; Fl. 36,-; $10.00.

Twenty papers were presented at the conference. A separate abstract was prepared for each. (J.C.W.)

For abstracts of individual papers see: 35358-35360, 35392-35402, 36173, 36293, 36294, 37482, 37504, and 37505.

36173 (EUR-4190, pp 25-52) GRANULAR MATERIALS: RANGE OF APPLICATIONS AND PROBLEMS. Jeschar, R.; Neumann, H. (Technische Hochschule, Clausthal-Zellerfeld (West Germany). Institut fuer Waermetechnik und Industrieofenbau). (In German).

The range of applications and the classifications of bulk materials are discussed. Bulk materials are defined and the characteristics given. The properties of single particles forming bulk materials, structure and behavior of bulk materials at rest and in motion, heat and mass transfer, and chemical reactions which take place in bulk materials are discussed. The problems handling bulk materials (pressure distribution in bins and hoppers, discharge processes, arching); single- and multicurrent flow, (pressure drop, velocity distribution, and flooding); transverse and longitudinal diffusion; heat conduction; heat and mass transfer; and heterogeneous reactions are considered. (auth)

36174 EFFECT OF CRACKS ON CREEP RATE. PART II. EXPERIMENTAL. Green, W. V. (Los Alamos Scientific Lab., N. Mex.); Zukas, E. G.; Weertman, J. ASM (Amer. Soc. Metals), Trans. Quart., 62: 512-20(June 1969).

A comparison is made between displacement distribution curves computed using theory and experimentally determined curves. The case examined is highly oriented anisotropic material containing one large crack in a matrix containing a large number of small cracks. The enhancement of creep rate due to cracks in this material should be large according to theory. The displacement diagrams predicted by theory and determined by experiment agree reasonably well, even though the theory was developed for Newtonian creep whereas the graphite studied has a much stronger stress dependence of its creep rate. (auth)

36175 CANNING OF VITROCERAMIC NUCLEAR FUELS. I. STABILITY OF THE FUEL-CLADDING-COOLANT SYSTEM. Maxim, I. V. (Institut de Physique Atomique, Bucharest). J. Nucl. Mater., 31: 330-8(July 1969). (In French).

A study was made of appropriate canning materials and coolant for glass-ceramic fuel elements, based on UO_2 and SiO_2, to allow a stable and compatible system to be established under reactor conditions. It is necessary to choose materials which satisfy these requirements and moreover allow use of natural uranium for producing fuel elements. A suitable coolant liquid consists of 5% CO and 95% CO_2. The fuel elements can be canned in glasses based on alumino-silicates or on phosphates or with ceramic films based on Al_2O_3 or metallic films based on chromium or chromium-nickel alloys. (auth)

36176 INVESTIGATION OF GRAPHITE AND PYROGRAPHITE INTERACTION WITH TITANIUM AND ZIRCONIUM NITRIDES. Burykina, A. L.; Evtushok, T. M. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 51-8 (May 1969). (In Russian).

Interaction of titanium and zirconium nitrides with graphite and pyrographite was investigated in vacuum at 0.1 Newton/m^2 in the temperature range of 1673 to 2473°K and contact time of 1 to 5 hours. It is shown that as a result of the interaction the carbide phases are formed changing into the solid solution MeC-MeN at the interface with nitride. A thermodynamic estimation of the possibility of graphite interaction with nitrides is in satisfactory agreement with the results of the experiment. (auth)

Corrosion and Erosion

Refer also to abstracts 36023, 36024, and 36101.

36177 METHOD OF DETERMINING THE INTEGRITY OF COATING OF A URANIUM CARBIDE KERNEL. (to United Kingdom Atomic Energy Authority). French Patent 1,428,688. Filed Mar. 15, 1965.

A method is described of determining the integrity of coating of a uranium carbide kernel coated with a material which is less reactive with air or other oxidizing mediums than the uranium carbide. The method comprises subjecting the coated kernel alternately to air or other oxidizing medium and to vacuum in a high temperature environment, whereby any defect in the coating allows penetration of the air or other oxidizing medium to the kernel, thereby oxidizing the uranium carbide and producing local expansion of the kernel in the vicinity of the defect, such expansion being sufficient to burst the coating and reveal the defect. The process is carried out at a temperature of about 700°C and the cycling frequency change from air or other oxidizing medium to vacuum is about 5 minutes. After testing the kernels may be subjected to acid leaching, in boiling HNO_3, so that any kernel whose coating has burst is taken into solution and uranium can be recovered from the solution by conventional means. (NPO)

36178 ROLE OF IONS IN THE OXIDATION OF GRAPHITE BY RADIOLYSED CARBON DIOXIDE. Brewer, Judith M.; Feates, F. S. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 7: 393-5(June 1969).

^{14}C labeled graphite was used to demonstrate that positively charged ions (probably CO_2^+) play a significant role in the oxidation of graphite by γ-radiolyzed carbon dioxide. About 40% of the total reactivity is attributed to ions. (auth) (UK)

36179 PROCESS FOR PREVENTING THE FORMATION OF A CARBON DEPOSIT ON THE SURFACE OF HEAT EXCHANGERS IN NUCLEAR REACTORS. (to Brown Bovery/Krupp Reaktorbau GmbH). French Patent 1,454,595. Filed Oct. 7, 1965.

In order to prevent the formation of a carbon deposit on the surface of heat exchangers in nuclear reactors the chemical composition and the physical conditions of the gaseous coolant of the reactor are chosen in such a way that free carbon, formed during operation, is transformed into a gaseous reaction product, preferably by catalytic synthesis of hydrocarbons, hydrogen and hydrogenation catalyzers being added to the coolant. (NPO)

36180 STABILITY OF TRANSITION METAL CARBIDES UNDER CONDITIONS OF ANODE POLARIZATION. Semenov-Kobzar, A. A.; Obolonchik, V. A.; Akinina, Z. S. Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 75-8(May 1969). (In Russian).

The stability was investigated of some carbides of transition metals in solutions of sea water and nitric acid. Chromium and tungsten carbides manifested the best stability. A decrease of the carbide stability in sea water is explained by an increasing effect of the oxidant-chlorate on the carbide solubility. A growth of the carbide stability in nitric acid with an increase in its concentration is explained by the formation of the oxide layer inhibiting the carbide oxidation. (auth)

Preparation and Fabrication

Refer also to abstracts 35275, 35386, 35761, 36036, 36040, 36045, 36218, and 37818.

36181 (EUR-4074(Pt.2)) MECHANICAL PROPERTIES OF Al-Al_2O_3 COMPOSITES. PART II. FRITTOXAL. Boerman, D. J.; Grin, M.; Veaux, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 29, 1968. 69p. Dep.

The main mechanical properties of Frittoxal, which is the trade name of an aluminum-alumina composite, are discussed. Frittoxal is a product which differs from the Al-Al_2O_3 composites, known as SAP, mainly by the fact that the starting material is not really a powder of round particles but a powder composed of aluminum flakes. The manufacturing process of finished products is explained and the conventional symbols for the identification of powders are recalled. The mechanical properties of finished products obtained from standard grades of Frittoxal are described. Finally the influence of starting powder and of thermal treatments is analyzed. (auth)

36182 (RFP-715) PREPARATION AND PROPERTIES OF PLUTONIUM CARBONITRIDE. Guyton, J. L.; Thompson, M. A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). June 1966. 7p. (CONF-660606-59). Dep. CFSTI.

From American Nuclear Society Meeting, Denver, Colo.

Three possible methods for the preparation of plutonium carbonitride were considered: reactions of ammonia with Pu-PuC cermet, reactions of ammonia with PuC, and reactions of PuC with PuN. The most promising of these methods appeared to be the reaction of ammonia with PuC. In most cases a pure single-phase plutonium carbonitride did not result. Some properties were studied. (M.C.G.)

36183 NITRIDE NUCLEAR FUEL AND PROCESS FOR ITS PRODUCTION. (to Deutsche Akademie der Wissenschaften). French Patent 1,489,718. Filed May 26, 1965.

Nitride nuclear fuel particles of substantially spherical shape are described in which ceramic nuclear fuel cores are covered with a mantle of nuclear fuel nitride. Preferably said cores consist of U-, Pu- or Th-nitride or a mixture thereof. The fuel particles are produced by reacting gaseous ammonia at a temperature between 1000 and 1600°C with a gaseous halide of a nuclear fuel, such as hexafluoride of U or Pu, or tetrahalide of U, Pu or Th, the fuel cores being present in the reaction zone. Preferably the reaction is carried out in a fluidized bed reactor. (NPO)

36184 COATING NUCLEAR REACTOR FUEL OR FERTILE PARTICLES. (to Gesellschaft fuer Kernenergieverwertung in

Schiffbau und Schiffahrt mbH). French Patent 1,504,355. Filed Dec. 13, 1966.

A process is described for coating nuclear fuel or fertile particles with a protective layer consisting of organic Si-compounds, which are formed by pyrolytic decomposition of organo-silanes, having Si-C, Si-H or Si-Si bonds. The decomposition is effected in one step at a temperature above 1000°C or in two steps, the first being realized at a temperature in the range 300 to 600°C. Silanes having Si-C bonds may be mixed with silanes having Si-N or Si-O bonds or with organic Ti- or Zr-compounds. (NPO)

36185 ELEMENT OF FISSILE MATERIAL CONTAINING A BURNABLE NEUTRON POISON. (to Reactor Centrum Nederland). French Patent 1,447,546. Filed Aug. 20, 1965.

Fissile elements based on UO_2 containing a dispersed burnable neutron poison are described which consist of a U- and/or Th-boride, such as tetraboride, that are unreactive with UO_2 at reactor operating temperatures. The poison should be in the form of spherical grains having a diameter in the range 100 to 500 μ, evenly distributed in a UO_2 matrix. Rods or tablets may be made by mixing grains of the poison with UO_2 powder, compressing the mixture to the desired shape and sintering the compressed powder until the rods or tablets have attained the required density. In a modification the powder mixture is introduced into a tube and compressed by mechanical vibration or by swaging the tube. (NPO)

36186 IMPROVEMENT IN THERMIONIC NUCLEAR FUEL ELEMENT. (to Siemens-Schuckertwerke Aktiengesellschaft). French Patent 1,466,406. Filed May 24, 1966.

A fuel element is described comprising thermionic diodes connected in series, and nuclear fuel disposed inside the emitter electrodes, a space being provided between the inner wall of the emitters and the fuel to accommodate the expansion of the latter during operation. The improvement consists in the use of a fuel which is composed of particles having a diameter not exceeding 1μ, embedded in a metallic matrix. In addition the spaces may be provided with channels connecting them with the atmosphere or with the gap between the emitter and the collector electrodes. Preferably said spaces and channels are periodically rinsed by means of cesium vapor. (NPO)

36187 PROCESS FOR INCREASING THE DENSITY OF NUCLEAR FUEL CARBIDES. (to Atomic Energy of Canada Ltd.). French Patent 1,510,605. Filed Feb. 8, 1967.

A process is described for the production of fuel carbides of at least 95% of the theoretical density. A tablet consisting of the monocarbide of U, Pu, or Th or a mixture thereof is placed in a mold, a pressure between 35 and 3500 kg/cm^2 is applied, and an electric current having a tension of 0.2 to 20 V and a current-density of 1550 to 7550 A/cm^2 is passed through the tablet. The parts of the mold which are contacting the tablet consist of or are cladded with Zr-, Be-, Th- or Mg-oxide, Si- or Al-nitride, or Ca- or Mg-zirconate. (NPO)

36188 CAN FOR FUEL ELEMENTS OF A GAS-COOLED NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,391,076. Filed Jan. 21, 1964.

A fuel element can is described which is provided with cooling fins and with radially extending longitudinal centering fins integral with the can, acting as flow dividers. The fins are adapted to center of the can in a cylindrical sleeve of neutron-moderating material and are disposed at equal angular intervals around the axis of the fuel element. The fins terminate at a distance short of each end of the can which is at least equal to the radial distance to which they extend from the can, the terminal edges of the fins have a rounded shape in the portion that joins the can. Each fin may be divided into several sections by means of at least one radial cut which extends in depth at least to the level of the fin tips. (NPO)

36189 PRODUCTION OF AN EXTRUSION MIXTURE CONTAINING POWDERED CERAMIC NUCLEAR FUEL. (to United Kingdom Atomic Energy Authority). French Patent 1,411,642. Filed Oct. 16, 1964.

Production is described of an extrusion mixture containing a powdered ceramic nuclear fuel, a binder, and a solvent for the binder. The mixture has the consistency of a thick paste. The powdered fuel is mixed with an organic liquid which does not react with the fuel and the binder. A solution of the binder in water is added to the mixture, causing a major part of the organic liquid to be driven out of the mixture forming a separate layer which is decanted. The mixture is then air-dried for a time long enough to evaporate the remainder of the organic liquid and as much of the water as is necessary to obtain a paste having the consistency required for extrusion. A lubricant such as glycerol is added to the initial mixture which is air-dried to such an extent that the binder, the lubricant, and the water comprise 6 to 7 wt % of the final mixture. (NPO) (UK)

36190 PROCESS FOR MAKING CONNECTIONS TO IMPREGNATED GRAPHITE MEMBERS. Burg, Henri; Lanza, Franco; Marengo, Giuseppe (to EURATOM). British Patent 1,157,863. July 9, 1969. Priority date Mar. 9, 1966, Italy.

A process for the production of fuel elements is described in which the elements are so constructed that the fissile materials are contained in metal-impregnated graphite sheaths or blocks in which filler plugs are threaded and brazed. Impregnation of the graphite enhances its strength and renders it impervious to fission products. The advantages of fuel elements fabricated in this way, according to the invention, include greater neutron economy, better heat exchange, and less stringent tolerances. (J.R.D.)

36191 HERF DENSIFIES CERAMICS, CERMETS, AND COMPOSITES. Williford, J. F. Jr. Ceram. Age., 84: No. 12, 28-33(Dec. 1968).

Uranium dioxide, with a density approaching the theoretical, has been produced on a high-energy rate forming pneumatic-mechanical impaction machine. Microstructural study shows that the density increase is a result of grain sliding, particle fracture and plastic deformation. Pneumatically impacted UO_2, PuO_2, and UO_2-PuO_2 solid solutions show a relatively large volume change during postimpaction annealing and there is some evidence of recovery and recrystallization. Dense cermets have also been produced, as in the case of a promethia-tungsten cermet encapsulated in W–Re to provide a radioisotope heat source. HERF has also produced a SiC filament-reinforced Ti-6Al-4V alloy. Evaluation techniques for ceramic materials include electron microprobe analysis, x-ray diffraction and thin section petrography. (Metals Abstr.)

36192 URANIUM DIOXIDE–YTTRIUM OXIDE–ZIRCONIUM DIOXIDE MICROSPHERES. (to W. R. Grace and Co.). British Patent 1,157,766. July 9, 1969. Priority date Mar. 16, 1967, United States.

A process is described for the preparation of solid-solution $UO_2-Y_2O_3-ZrO_2$ microspheres. The microspheres are prepared by mixing an ammonia releasing agent with a feed comprising aqueous double salts of U^{+4}, Y^{+3}, and ZrO_2 at room temperature. The mixture is warmed sufficiently to release ammonia which reacts with the metals in the aquasols to form the homogeneous oxide gels. (J.R.D.)

36193 PROCESS FOR COVERING THE END-FACES OF A NUCLEAR FUEL BAR WITH A CERAMIC. (to United Kingdom Atomic Energy Authority). French Patent 1,411,641. Filed Oct. 16, 1964.

A process is described for applying a ceramic covering to the end-faces of dispersion-type nuclear fuel bars which consists of a fritted ceramic fissile material such as UO_2, dispersed in a matrix of a fritted ceramic non-fissile material such as BeO. The process comprises treating the planed end-face with 50 vol % HNO_3 to dissolve the exposed UO_2-particles, covering the end-face with a first disc consisting of a cold-pressed mixture of BeO-powder and flux, preferably being 62 wt % SiO_2, 20 wt % Al_2O_3, and 18 wt % MgO, and constituting 25 wt % of the disc, superimposing on the first disc a second disc consisting of fritted BeO-powder, and hot-pressing the unit in a suitable mold at a temperature of about 1450°C in a H_2-atmosphere for about one hour under a pressure of about 140 kg/cm^2. (NPO)

36194 PROCESS FOR THE PRODUCTION OF A NITRIDE NUCLEAR FUEL. (to EURATOM). French Patent 1,437,093. Filed June 11, 1965.

A process for the production of a nuclear fuel having a base of U-mononitride is described which comprises reacting a U-Ti-alloy containing 5 to 20 wt % Ti with N_2 in an electric arc at a pressure preferably not exceeding 5 atm. The product comprises a matrix of stoichiometric UN containing dispersed discrete particles of $Ti_{(1+x)}N$, x being a positive number. (NPO)

36195 SUPPORT FOR NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,433,592. Filed Feb. 19, 1965.

A fuel cartridge is described comprising a canned fuel element, a cylindrical sleeve surrounding and spaced from the element, and a support on which the element rests. The support is disposed in the sleeve incorporating a spacer. The support comprises a cylindrical bracket resting on at least three circumferentially equi-spaced members each releasably engaging in a recess in the bracket and in a toric groove in the internal surface of the sleeve. The members are held in position by the action of gravity on the

fuel element and the bracket. Preferably each member comprises a disc which engages in the groove and in a vertical slot machined in the bracket, the plane of the disc including the axis of the cartridge. In a modification the members are spherical and engage in said toric groove and in a vertical groove in the bracket. Preferably the sleeve, support, and members consist of graphite. (NPO)

36196 ZIRCONIA-BASED THERMOELECTRIC COMPOSITIONS. McVey, C. I.; McConnaughey, N.; Gibson, H. D.; Smith, J. V. (to United States Atomic Energy Commission). U. S. Patent 3,449,175. June 10, 1969.

A thermoelectric element is described comprising a densified body having electrical leads at opposed portions of the body. The body is formed by a process of intimately mixing zirconia, a metal selected from zirconium, titanium, vanadium, and yttrium, and a metal oxide selected from yttria, calcia, and a 4f rare earth oxide. The mixture is densified by heating to at least its sintering temperature in an inert atmosphere and at a pressure sufficient to form a dense coherent body having a matrix of zirconia and selected metal oxide in which the concentration of metal is between about 4 wt % and its solubility limit in the matrix at the intended service temperature. (AEC)

36197 HIGH-ENERGY SPRAYING OF WEAR RESISTING COATINGS. Technica (Basel), 17: 2331-2(Nov. 22, 1968). (In German).

A description of the processes used for the application of coatings of W and Cr carbides, Al_2O_3, and other hard materials, by means of oxyacetylene detonation guns and plasma spray pistols, is presented. (Metals Abstr.)

36198 PROCESS FOR THE PRODUCTION OF URANIUM DICARBIDE NUCLEAR FUEL. (to United Kingdom Atomic Energy Authority). French Patent 1,428,778. Filed Mar. 18, 1965.

A process is described for producing UC_2 particles, having a density at least equal to 85% of the theoretical density. The process comprises mixing UO_2 with a binder, e.g., Al-stearate, and with a quantity of C which slightly exceeds the stoichiometric quantity for the production of UC by the reaction $UO_2 + 3C = UC + 2CO$, graining the mixture to spheroidal particles, fritting the particles, and depositing pyrolytic C on the surface of the particles in a fluidized bed at a temperature above 1500°C until the UC is completely transformed into UC_2. The rate of deposition of the pyrolytic C has to be inferior to the reaction velocity of the carburization of the UC. (NPO)

36199 METHOD FOR THE PRODUCTION OF NUCLEAR FUEL MONOCARBIDES. (to United Kingdom Atomic Energy Authority). French Patent 1,411,686. Filed Dec. 20, 1963.

A method is described for the production of a nuclear fuel monocarbide comprising reacting a higher carbide with H_2 at a temperature of not less than 1000°C, the H_2 containing less than 25 ppM by volume of H_2O-vapor and less than 1 ppM by volume of O_2. The higher carbide is raised to the reaction temperature and after the reaction cooled down in an atmosphere of Ar containing not more than 8 ppM by volume of H_2O-vapor and 1 ppM by volume of O_2. Reduction and sintering of the material may be carried out simultaneously by heating to about 1500°C in H_2. If the higher carbide is UC_2 or a mixture of U and Pu higher carbides, the reaction time at 1000°C is at least 3 hours. With Pu_2C_3 however a heating period of 6 hours is necessary. The H_2 is caused to flow over the higher carbide at a rate of approximately 1 liter/min. (NPO)

36200 PROCESS FOR DEOXIDIZING URANIUM AND PLUTONIUM CARBIDES. (to Commissariat a l'Energie Atomique). French Patent 1,413,959. Filed Aug. 25, 1964.

A process is described for the deoxidation of U- and Pu-carbides. This comprises grinding the carbide to be treated, grinding a metal or its hydride selected from the group Ca, Sr, Ba, Mg and Al, and vacuum heating the mixed powders at a temperature which is sufficiently high to reduce the UO_2 contained in the carbide. The quantity of metal or hydride, preferably CaH_2, slightly exceeds the quantity stoichiometrically required. The mixture is heated at a temperature above 700°C. In order to produce fritted bodies Fe-, Ni- or Co-powder, in a quantity not exceeding 1%, is added to the mixture which is then compacted and vacuum heated at a temperature between 1400 and 1500°C for 4 hours. (NPO)

36201 SINTERED URANIUM DIOXIDE. (to United Kingdom Atomic Energy Authority). French Patent 1,476,488. Filed Apr. 20, 1966.

A UO_2 ceramic is described which does not exhibit columnar grain growth when subjected to a severe temperature gradient at temperatures between 1600 and 2000°C. The ceramic contains preferably 0.2 to 2.0 wt % of Ir and may be produced by adding finely divided metallic Ir to UO_2 powder and sintering the mixture, or by mixing UO_2 powder with a solution of an Ir compound, e.g., $(NH_4)_3IrCl_6 \cdot H_2O$, so as to form a slurry, drying the slurry, converting the Ir compound into metallic Ir by thermal decomposition, and compacting and sintering the powder so obtained to produce a ceramic fuel body. The thermal decomposition is effected simultaneously with the production of the ceramic body. It is advantageous to use UO_2 which has been enriched in its ^{235}U content. (NPO)

36202 METHOD FOR MANUFACTURING DENSE PARTICLES OF NUCLEAR FUEL. (to Nukem, Nuklear-Chemie and -Metallurgie Gesellschaft mbH). French Patent 1,430,512. Filed Mar. 5, 1965.

A method for the manufacture of dense particles of nuclear fuel, particularly UO_2 and PuO_2 is described. Finely divided dioxide is mixed with an organic binder such as polyethylene-glycol, the latter being present in a quantity of 1 to 2 wt %. The mixture is heated and compacted by pressing or calendering. The mixture is then ground to the desired particle size and fritted. After the grinding the particles may be rounded and subjected to fractional sieving, the particles having an undesired grain size being returned to the compacting step. After vibration of the non-fritted particles a mean density is obtained corresponding with about 87% of the theoretical value. The density of the fritted product amounts to about 95% of the theoretical density. (NPO)

36203 METHOD OF GRANULATING A CERAMIC NUCLEAR FUEL. (to United Kingdom Atomic Energy Authority). French Patent 1,438,020. Filed June 28, 1965.

A method of granulating a ceramic nuclear fuel is described which comprises mixing the fuel in powder form with a solution of a binder in an excess of a non-aqueous solvent having a low hydrogen content such as a chlorinated hydrocarbon, to form a slurry, and spray-drying the slurry to produce dry granules of the fuel intimately incorporating the binder. If the fuel consists of UO_2 or a mixture of UO_2 and PuO_2 the binder preferably is polybutylmethacrylate in dibutyl phthalate and the solvent is trichlorethylene. (NPO)

36204 NUCLEAR FUEL. (to United Kingdom Atomic Energy Authority). French Patent 1,417,464. Filed Nov. 24, 1964.

A nuclear fuel is described which comprises a mixture of U- and Pu-sesquicarbides, the latter being present in a quantity of 8 to 40 mole %, preferably 20 to 22 mole %. In preparing the sesquicarbides care must be taken to minimize the quantity of oxygen in the product. (NPO)

36205 COATING NUCLEAR REACTOR FUEL OR BLANKET PARTICLES WITH PYROLYTIC CARBON. (to NUKEM Nuclear-Chemie und -Metallurgie GmbH). French Patent 1,499,665. Filed Nov. 9, 1966.

A process is described for coating nuclear fuel or blanket particles with pyrolytic carbon in a fluidized bed. Production, coating, and fritting the particles are effected in one operation by raising the temperature step-by-step in the range 1000 to 2550°C, the pressure being in the range 10 to 760 torr or in the range 760 to 1000 torr. In an example particles of UO_2 and ThO_2 are reacted at 1700°C with particles of C to obtain the corresponding mixed carbides which are then provided with a coating of pyrolytic carbon produced by the thermal decomposition of methane at the same temperature, the coating having a thickness of 30μ. The temperature is then raised to 2000°C and held at this level until the thickness of the coating amounts to 100μ. At the same time the core contracts due to fritting, leaving a void between the core and the coating of about 10μ. (NPO)

36206 FABRICATION AND CHARACTERIZATION OF URANIUM–PLUTONIUM CARBIDE FUEL PELLETS. Bale, M. G.; French, P. M.; Hodge, M. H.; Jacoby, W. R.; Shalek, P. D.; Wallace, T. W.; Wolcott, N. G. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 86(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36207 POROUS UO_2 BODIES PRODUCED BY REDUCTION OF U_3O_8. Washburn, T. N. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 206-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36208 PREPARATION OF CARBIDE MICROSPHERES BY THE SOL-GEL PROCESS. Bond, W. D.; Buxton, S. R.; Notz, K. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 207-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36209 METHOD FOR THE PRODUCTION OF A NUCLEAR FUEL BODY OF URANIUM DIOXIDE. (to United Kingdom

Atomic Energy Authority). French Patent 1,412,878. Filed Oct. 29, 1964.

A method for the production of a fuel body of UO_2 is described which comprises mixing UO_2 powder of a form which after compaction sinters to a high density with powder of a higher oxide of uranium such as U_3O_8, UO_3, or UO_4; the UO_2 predominating. Mixing is limited to a degree such that agglomerates of the powder of the higher oxide are in a continuous matrix of UO_2 powder. The mixture is compacted and sintered in a reducing atmosphere in which the higher oxide becomes reduced to UO_2 and in so doing shrinks more than does the UO_2 originally present. In this way a body of high density UO_2 containing discrete regions of internal porosity is produced. The surface area of the UO_2 employed should be 2 to 6 m^2/g and the surface area of the higher oxide employed should be 0.5 to 12 m^2/g, the higher oxide being employed in a proportion of 5 to 30 wt % of the total mixture. It is advantageous to use UO_2 which has a natural ^{235}U content and a higher oxide which has been enriched in its ^{235}U content. (NPO)

36210 SINTERED URANIUM DIOXIDE. Elyard, Charles Anthony; Potter, Terence Jefferson (to United Kindgom Atomic Energy Authority). British Patent 1,155,969. June 25, 1969. Filed Oct. 14, 1965.

A process is described for the preparation of ceramic UO_2 which does not undergo columnar grain growth when used as nuclear reactor fuel and which therefore has improved fission gas retention properties. The UO_2 contains Nd_2O_3 in the concentration range 0.75 to 3% by weight. The dry oxides are mixed together, compacted, and sintered; alternatively, the Nd may be added as a solution of one of its compounds, the resulting slurry being dried and the neodymium compound decomposed to Nd_2O_3, followed by compacting and sintering. (UK)

36211 PRODUCTION OF BARS OF NUCLEAR FUEL CARBIDES BY EXTRUSION. (to Commissariat a l'Energie Atomique). French Patent 1,409,455. Filed July 17, 1964.

Fuel bars consisting of carbides, especially UC, are produced by extrusion of the carbides at a temperature of 2200 to 2400°C and a pressure of 200 to 800 kg/cm^2, using a graphite nozzle having a conic or preferably hyperbolic extruding surface so as to reduce the section of the nozzle channel in a ratio of at least 2:1, preferably 10:1. (NPO)

36212 IMPROVEMENT IN THE PRODUCTION OF BARS OF NUCLEAR FUEL MONOCARBIDES BY EXTRUSION. (to Commissariat a l'Energie Atomique). French Patent 1,409,455. Filed June 21, 1965.

The production of bars of nuclear fuel monocarbides by extrusion of the carbides at a temperature of 2200 to 2400°C and a pressure of 200 to 800 kg/cm^2 using a graphite nozzle is described. The cylinder into which the carbide to be shaped is inserted is composed of graphite which has a high mechanical resistance and its inner wall is cladded with a replaceable sheath of ordinary graphite. In order to increase the velocity of extrusion an intermediate layer of UC_2 is provided between the sheath and the carbide preferably by covering the surface of the carbide with a colloidal suspension of UC_2-particles. (NPO)

36213 NUCLEAR FUEL MATERIAL AND PROCESS FOR ITS MANUFACTURE. (to General Electric Co. Ltd.). French Patent 1,413,034. Filed Nov. 4, 1964.

A nuclear fuel is described consisting substantially of U-carbide having a composition in the range of 48 to 50 at. % of U and 52 to 50 at. % of C to which W is added in a quantity of 0.5 to 5.0 wt % of the total mixture. The fuel is manufactured by arc melting a mixture of U, C and W or a mixture of UC and W in the required relative proportions, and casting the melt to form a body of a desired shape and size. The W may be introduced into the mixture by employing a W-electrode for the arc melting. (NPO)

36214 BORON PLATING OF CERMET PARTS. Shibryaev, B. F.; Gribenyuk, Yu. N.; Shuvalova, T. A. Porosh. Met., Akad. Nauk Ukr. SSR, No. 6, 40-3(June 1969). (In Russian).

Boron plating of cermet iron-graphite bushings is considered. Optimal conditions for boron plating include t = 950°C, current density i = 0.15 A/cm^2, time of exposure—3 hr. Microhardness of cermet boron-plated bushings of iron-graphite is higher than that of unplated ones. (auth)

36215 PREPARATION OF URANIUM MONOCARBIDE. Becvar, J. (Inst. of Nuclear Research, Rez, Czech.). J. Nucl. Mater., 32: 156-60(Aug. 1969).

The carbothermic reduction of uranium dioxide in vacuum has been used to prepare uranium monocarbide with low oxygen and nitrogen contents. The effect of heating rate and reaction temperatures ranging from 1300 to 1900°C has been investigated. Uranium monocarbide with the lowest oxygen content was obtained by slowly heating a mixture of UO_2 with carbon to a reaction temperature of 1700°C. Uranium monocarbide was densified by sintering to 92 to 94% theoretical density. (auth)

Properties Evaluations

Refer also to abstracts 35112, 35994, 36023, 36073, 36101, 36181, 36277, and 36281.

36216 (ALO-2510-5) SILICON GERMANIUM THERMOELECTRIC MATERIALS AND MODULE DEVELOPMENT PROGRAM. 5th Quarterly Report, January 1, 1969–March 31, 1969. (Radio Corp. of America, Harrison, N. J.). Contract AT(29-2)-2510. 103p. Dep. CFSTI.

Operation of a drop calorimeter facility to measure specific heat of silicon systems was initiated during the period. Progress is also reported on establishment of a capability to coat graphite hot shoes with Si to allow for air operation. Selection of 80 to 83% Si-content SiGe for further examination is reported. Operation of thermoelectric converters at high temperatures during the period is discussed. Efforts devoted to parametric analyses of SiGe hot stage using a computer are summarized. (J.R.D.)

36217 (BAW-3714-13) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 11, February–April 1969. Carlson, R. V. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). June 1969. Contracts AT(30-1)-3714; 859-3100. 22p. Dep. CFSTI.

Development of a sol-gel process is reported in which the preparation of UO_2–20% PuO_2 sol-gel spherical fuel in two size ranges for thermal reactor testing was completed. Two uranium enrichments—depleted UO_2 and 20% enriched $^{235}UO_2$—were used to prepare materials that will yield two different heat rates with fuel of the same U/Pu ratio. Also completed are the six initial capsule irradiation tests in a series that will show the differences in the restructuring kinetics of pellets and vibratory compacted spheres and shards. The heat rate varied from about 5 to 20 kW/ft, and the exposure time varied from about 1 to 9 EFPD. All the capsules are cooling pending hot cell examination. The seventh capsule in the series has been fabricated. The evaluation of procedures for the determination of moisture content and oxygen stoichiometry in mixed oxide fuels is complete. The average relative standard deviation from a series of oxygen-to-metal analyses was found to be 0.176%. Oxide characterization and chemical analyses of the fuels for thermal reactor testing are summarized. (auth)

36218 (EUR-4074(Pt.1)) MECHANICAL PROPERTIES OF Al–Al_2O_3 COMPOSITES. PART I. SAP-ISML. Boerman, D. J.; Grin, M.; Veaux, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1969. 85p. Dep.

The mechanical properties (to 600°C) of the four SAP-grades (Sintered Aluminum Powder) are described. The fabrication process of the semifinished products (bars and tubes) and finished products (canning tubes and pressure tubes) is briefly described. The mechanical properties of the SAP-alloys are discussed including results of tension, compression, creep, and fatigue tests at various temperatures, and diagrams with the mechanical properties as a function of temperature or percentage of aluminum oxide. Finally the experimental conditions and some physical properties of SAP are described. (auth)

36219 (GEAP-5777) THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 6. Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Apr. 1969. Contract AT(04-3)-189. 9p. Dep. CFSTI.

Results of work related to measurement of liquidus-solidus transformations, vaporization of urania, and oxygen redistribution in a temperature gradient are presented. Preliminary data are presented on UO_2–20% PuO_2 thermal gradient experiments carried out in the temperature range 1200 to 1600°C. (auth)

36220 (LA-4155-TR) ENTHALPY AND SPECIFIC HEAT OF YTTRIUM SESQUIOXIDE AND CERIUM DIOXIDE AT ELEVATED TEMPERATURES. Yashvili, T. S.; Tsagareishvili, D. Sh.; Gvelesiani, G. G. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Soobshch. Akad. Nauk Gruz. SSR, 46: 409-13(1967). 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 32987.

36221 (LA-4158-TR) SCANDIUM SESQUIOXIDE ENTHALPY AND HEAT CAPACITY AT HIGH TEMPERATURES. Tsagareishvili, D. Sh.; Yashvili, T. S.; Gvelesiani, G. G. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from

Soobshch. Akad. Nauk Gruz. SSR, 49: 175-80(1968). 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 38633.

36222 (ORNL-4415) LIQUID-VAPOR EQUILIBRIA IN LiF-BeF_2 AND LiF-BeF_2-ThF_4 SYSTEMS. Smith, F. J.; Ferris, L. M.; Thompson, C. T. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 18p. Dep. CFSTI.

Liquid-vapor equilibrium data for several LiF-BeF_2 and LiF-BeF_2-ThF_4 systems were obtained by the transpiration method over the temperature of 900 to 1050°C. Relative volatilities, effective activity coefficients, and apparent partial pressures are tabulated for the major components, as well as for solutes such as UF_4, ZrF_4, CsF, RbF, and some rare-earth fluorides. The values are in reasonable agreement with those reported in the literature. Results of this study show that distillation may not be feasible as a primary separations method in the processing of single-fluid MSBR fuels. (auth)

36223 (RT/CHI-(69)2) ALPHA AUTORADIOGRAPHY OF IRRADIATED NUCLEAR FUEL. Trezza, G. (Comitato Nazionale per l'Energie Nucleare, Rome (Italy)). 1969. 25p. (In Italian). Dep.

The use of cellulose nitrate for the α autoradiography of irradiated nuclear fuel was investigated. The damage done to the cellulose nitrate by an α particle is described. The technique used for the autoradiography is discussed. The results showed that cellulose nitrate is very sensitive to this irradiation and can be easily detected. (J.S.R.)

36224 (RT/CHI-(69)5) BETA, GAMMA AUTORADIOGRAPHY OF IRRADIATED NUCLEAR FUEL. Marsico, B.; Trezza, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 25p. (In Italian). Dep.

The technique used for the photographic exposure, development, and reproduction of the autoradiograph of irradiated nuclear fuel is described. The preparation of the Kodak MR plates, preparation of the sample, exposure conditions and techniques, and the development and reproduction of the autoradiograph are discussed. (J.S.R.)

36225 THERMAL EXPANSION HYSTERESIS IN POLYCRYSTALLINE GRAPHITE. Slagle, O. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Carbon, 7: 337-44(June 1969).

The length of polycrystalline graphite samples was measured as a function of temperature during cycling from 1000 to 2400°C. A sample oriented perpendicular to the extrusion direction exhibited thermal expansion hysteresis for cycling to 2400 and 2200°C but little or no hysteresis for cycling to 2000 and 1800°C. A sample with parallel orientation displayed no measurable hysteresis when cycled to 2400°C. The results are discussed in terms of one-dimensional models which allow simulation of crystallite cracking during cool down. (auth)

36226 DIFFUSION OF GASES THROUGH GRAPHITE. Hawtin, P. (Atomic Energy Research Establishment, Harwell, Eng.); Dawson, R. W.; Roberts, J. Trans. Inst. Chem. Eng. (London), 47: T109-13(1969).

The effective diffusion coefficients of He/N_2, He/Ar, and CO_2/CH_4 through the pores of three types of graphite were measured at temperatures between 20 and 600°C. The results were expressed in terms of λ, the ratio between the effective and the corresponding free gas diffusion coefficients. The term λ was shown to be a constant dependent only on the graphite used in the experiment. (auth)

36227 SOME ELECTROPHYSICAL PROPERTIES OF TRANSIENT METAL DISILICIDES FROM V-VI GROUPS OF PERIODIC SYSTEM. Samsonov, G. V.; Grebenkina, V. G.; Dvorina, L. A. Porosh. Met., Akad. Nauk Ukr. SSR, No. 4, 42-7(Apr. 1969). (In Russian).

The temperature dependence of electric resistance and absolute differential thermo-emf at 25 to 1000°C and of the Hall constant at 25°C for the disilicides of transition metals from V and VI groups of the periodic system were investigated. The conductivity in these compounds is shown to be of metallic character. It is shown that the differential temperature coefficients of resistance of disilicides decrease with an increase in the statistical weight of metal atoms, having the stable electronic configurations of the localized part of valent electrons, which corresponds to the growth of rigidity modulus of crystalline lattice, as well as with a decrease in effective masses of carriers. (auth)

36228 STUDY OF STRUCTURE CHANGES IN ZIRCONIUM-NIOBIUM ALLOYS. Guerillon, J. P.; Quivy, A.; Lehr, P. (CECM, Vitry-sur-Seine, France). Mem. Sci. Rev. Met., 66: 321-30(Apr. 1969). (In French).

Alloys containing from 0.9 to 20.7 wt % Nb, homogenized and then quenched in oil after holding at 750°C for 16 hr, and finally temper treated were studied. Mechanisms and type of changes were observed along with properties of the various phases. (auth)

36229 BASAL THERMAL CONDUCTIVITY OF HIGHLY ORIENTED PYROLYTIC GRAPHITE AS A FUNCTION OF DEGREE OF GRAPHITISATION. Kelly, B. T.; Gilchrist, K. E. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Carbon, 7: 355-8(June 1969).

Measurements are reported of the temperature dependence of the thermal conductivity of well-oriented graphite deposited at 2100 to 2200°C and heat-treated to various temperatures up to 3000°C. The results are analyzed using the theory of crystallite-boundary limited conduction, together with an empirical equation for the thermal resistance due to Umklapp processes. The theory leads to values of the crystallite dimension L_a parallel to the basal planes which are plotted as a function of heat treatment temperature and compared with similar values derived from electron-hole mobilities and x-ray studies on similar material. The value of L_a is quite well described by an exponential function of temperature for the values obtained from the thermal and electrical properties. The x-ray results are smaller by a factor of ten. (auth) (UK)

36230 THERMAL ANALYSIS OF FAST REACTOR OXIDE FUELS. Rim, Chang Saeng; Fenech, Henri (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 103-4 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36231 FISSION-GAS DIFFUSION AND SOLUBILITY IN URANIUM MONOCARBIDE. Ritzman, R. L.; Price, R. B.; Morrison, D. L. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 79(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36232 DIFFUSIONAL BEHAVIOR OF STRONTIUM IN GRAPHITE. Besenbruch, G. E.; Norman, J. H.; Allen, C. L.; Weitzel, W. H. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 81(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36233 COMPUTER SIMULATION OF COMBINED VOLUME AND SURFACE DIFFUSION. Berman, Robert M. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 78(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36234 FISSION-GAS RELEASE FROM UO_2 DURING IRRADIATION UNDER EXTREME CONDITIONS. Carroll, R. M.; Morgan, J. G.; Perez, R. B.; Sisman, O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 76-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36235 A BIBLIOGRAPHIC SURVEY ON ZIRCONIUM ANODIC OXIDE. PART 1. Dassu, G. (Politecnico, Milan); Alessandrini, G.; Peruzzi, R. Energ. Nucl. (Milan), 16: 529-37(July 1969).

The status of research in the field of zirconium anodic oxide and its alloys is reviewed. Subjects such as influence of the material nature and the electrolyte chemical composition on the oxide morphology, observation techniques and thickness measurement methods, growth mechanism and ion and electron transport theories, chemical and physical properties related to technical applications are emphasized. Morphology and measurement methods are discussed. Data drawn from bibliography are collected in plots or tables. (auth)

36236 ELASTIC MODULI AND DEBYE TEMPERATURE OF POLYCRYSTALLINE URANIUM NITRIDE BY ULTRASONIC VELOCITY MEASUREMENTS. Whaley, H. L.; Fulkerson, W.; Potter, R. A. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 31: 345-50(July 1969).

Values of elastic moduli and Debye temperature were determined for pressed and sintered uranium mononitride cylinders and rods of densities of 92.8 to 98.5% theoretical. Ultrasonic velocities were measured at room temperature for each sample and then elastic moduli were calculated from the measurements. Debye temperatures for theoretically dense UN were calculated to be 361 and 364°K by two different methods. Because of poor agreement with a literature Debye temperature obtained from low-temperature specific heat measurements (1.3 to 4.7°K), velocity

measurements were repeated for the 92.8% density sample at liquid nitrogen (77°K) and at liquid helium (4.2°K) temperatures. Experimental agreement between the velocities obtained at room and low temperatures indicates the possibility of a real difference between the Debye temperature obtained from elastic constants and that obtained from low-temperature specific heat. (G.M.C.)

36237 ANSWER TO A COMMENT ON THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE AT VERY HIGH THERMAL GRADIENTS. Petrassi, E. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 31: 356-7(July 1969).

. Evidence is presented to show that the conclusion of Fulkerson, McElroy, and Moore (J. Nucl. Mat., 26: 223(1968)), that neither thermal gradients up to 40°C/cm nor compressive stresses up to 4240 psi have any effect on the thermal conductivity of monocrystalline UO_2, is based on insufficient experimentation. However, it should be noted that previous results indicating the reduction of thermal conductivity at very high thermal gradients (30 to 200°C/cm) should be completed by saying that not the thermal stresses themselves, but the related microcracks are responsible for the observed reduction of the thermal conductivity. (G.M.C.)

36238 FIBROUS REFRACTORY COMPOSITES PRODUCED BY ORIENTED CRYSTALLIZATION IN THE SYSTEMS Co–Cr–Ta–C AND Ni–Cr–Ta–C. Bibring, Herve; Rabinovitch, Maurice; Seibel, Georges (Office National d'Etudes et de Recherches Aerospatiales, Hauts-de-Seine, France). Compt. Rend., Ser. C, 268: 1666-9(May 12, 1969). (In French).

The addition of Cr to the pseudo-binary eutectic Co–TaC and its effects on the oriented growth coupled with fibers or lamella of the TaC monocarbide in the metallic matrix were investigated. The Cr addition did not affect the oriented growth. Theoretical considerations suggested a slight slope of the liquidus surface of the quarternary system in the vicinity of 13% TaC. Three series of cobalt base alloys containing 13% TaC were fabricated. The microstructure of these alloys with 5, 10, and 15% Cr was determined. The same morphology was observed in all three alloys. Rupture tests showed that the addition of Cr increased the strength of the alloy. Similar data were obtained with Ni. (J.S.R.)

36239 PHYSICAL PROPERTIES OF TRANSITION METAL MONOCARBIDES IN THEIR HOMOGENEITY RANGE. I. TiC_{1-x} AND NbC_{1-x}. Samsonov, G. V.; Upadkhaya, G. S. (Kiev Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 69-74 (May 1969). (In Russian).

Data on the physical properties of titanium and niobium monocarbides in their homogeneity range are discussed. Electric resistivity, Hall coefficient, thermo emf, magnetic susceptibility, and temperature dependence of electric resistivity and thermo emf at 50 to 1000°C of titanium and niobium monocarbides in their homogeneity range were studied and the results were interpreted on the basis of the formation of stable sp^3-configurations of C-atoms. (auth)

36240 INVESTIGATION OF THE COEFFICIENT OF THERMAL EXPANSION OF ALLOYED CERIUM SULPHIDE IN THE HOMOGENEITY RANGE Ce_2S_3–Ce_3S_4. Goryachev, Yu. M.; Kutsenok, T. G. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 59-62(May 1969). (In Russian).

The change of the thermal expansion coefficient was investigated in the homogeneity range of cerium sulfate and also in alloying it with transition metals. A fall of the thermal expansion coefficient was found with a decrease of the lattice imperfection. An analysis is given of the thermal expansion coefficient correlation with the melting temperature and phonon component of heat conductivity of these alloys. (auth)

36241 BIAXIAL FRACTURE STRENGTH AND MECHANICAL PROPERTIES OF GRAPHITE-BASE REFRACTORY COMPOSITES. Weng, Tu-lung (Union Carbide Corp., Parma, Ohio). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 851-8(May 1969).

Room-temperature mechanical properties of graphite-base refractory composites have been measured as functions of porosity and composition. Room temperature biaxial stress-strain properties of a composite with a nominal metallic composition of 50% have also been determined with thin-walled cylindrical specimens subjected to combinations of internal pressure, external pressure, and axial load. Stress and strain under combined stresses have been correlated with a generalized stress-strain relation. Biaxial fracture strength can be predicted satisfactorily by the modified maximum stress theory in the biaxial-tensile stress state and by the fracture criterion proposed by Norris et al. in the other stress states. Biaxial fracture envelopes as functions of porosity and composition have also been obtained with these theories of fracture for the composites. (auth)

36242 SELF-DIFFUSION OF CARBON IN URANIUM MONOCARBIDE. Krakowski, R. A. (Ohio State Univ., Columbus). J. Nucl. Mater., 32: 120-5(Aug. 1969).

The self-diffusion of carbon in uranium monocarbide has been determined as a function of temperature in the range 1338 to 1772°K. A radiotracer technique has been employed which monitors the change in surface activity as a function of annealing time. The following expression adequately represents the data over the entire range of temperature studied. $D = 0.1 \exp(-62{,}500/RT)$ cm^2/sec. (auth)

Structure and Phase Studies

Refer also to abstracts 36134, 36143, 36238, 36289, and 36291.

36243 (SC-T-69-1030) PRESSURE-TEMPERATURE-COMPOSITION DIAGRAM OF THE URANIUM–HYDROGEN SYSTEM. Guinet, Ph. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from J. Nucl. Mater., 25: 24-37(1968). 21p. Dep. CFSTI.

The various diagrams: temperature-composition, pressure-composition, and pressure-temperature, in the uranium–hydrogen system, have been drawn, using the most recent data on the solid-gas equilibrium pressure at various temperatures and compositions. These representations bring forth two four-phase invariant equilibria; they show that in both isobaric diagrams for pressures higher than 83 atm and isothermal diagrams for temperatures higher than 820°C, the domains of the two phases $(U_\gamma H)$ (a solid solution of hydrogen in γ-uranium) and UH_n (uranium hydride) join themselves to make a single phase. The conditions for obtaining non-congruent melting of the hydride are deduced, for either constant pressure or constant temperature. Various types of isobaric or isothermal reactions are discussed with respect to their dependence on temperature or pressure. (auth)

36244 (TID-25123) INVESTIGATION OF THE MECHANICAL PROPERTIES OF TRANSITION METAL CARBIDES AND BORIDES. Final Report. (Little (Arthur D.) Inc., Cambridge, Mass.). Oct. 14, 1967. Contract AT(30-1)-3411. 70p. Dep. CFSTI.

Activities in a program designed to examine the high temperature deformation mechanism of single crystals of zirconium carbide and zirconium diboride are reported. Experiments were carried out on large, high purity, well characterized single crystals of high crystallographic quality to determine the slip direction, active slip planes, the critical resolved shear stress as a function of temperature, and the steady state creep rate as a function of stress and temperature. Information from studies on high temperature deformation of ZrC single crystals is presented along with data and discussions concerning ZrB_2 slip systems, and creep of polycrystalline ZrC. (J.R.D.)

36245 EFFECT OF DEVIATIONS FROM STOICHIOMETRIC COMPOSITION ON DIFFUSION-CONTROLLED PROCESSES IN INTERSTITIAL PHASES. Andrievskii, R. A.; Spivak, I. I.; Tsulin, A. E. Dokl. Akad. Nauk SSSR, 185: 792-4(1969). (In Russian).

Most interstitial phases such as the nitrides, carbides, and hydrides of the transition metals possess a wide region of homogeneity. Deviations from stoichiometry of niobium carbide are correlated with changes in the rate of creep. The composition was varied from $NbC_{0.97}$ to $NbC_{0.83}$. The creep rate was found to be a linear function of the applied force at 2900°C with the creep rate having a higher value for $NbC_{0.97}$ than for $NbC_{0.93}$. The effective rates of diffusion were estimated from the atomic fractions of the metallic and nonmetallic components, their coefficients of self-diffusion, and the concentration of structural vacancies in the nonmetallic sublattice. The agreement between the calculated and experimental data was satisfactory. The linear character of the dependence of creep rate as a function of unit stress indicates that directed self-diffusion and nonconservative migration of dislocations play a predominating role in the experimental results. (TTT)

36246 CHROMIUM–BORON SYSTEM DIAGRAM. Portnoi, K. I.; Romashov, V. M.; Romanovich, I. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 4, 51-7(Apr. 1969). (In Russian).

A new investigation was carried out of chromium–boron systems with application of a thermal analysis based on observing the drop formation as well as with roentgenostructural, microstructural and local roentgeno-spectral analyses of the alloys. A specified shape of the diagram is suggested within the whole range of concentrations. (auth)

36247 SOME OBSERVATIONS ON THE DEFORMATION CHARACTERISTICS OF BULK POLYCRYSTALLINE ZIRCONIUM

HYDRIDES. PART I. THE DEFORMATION AND FRACTURE OF HYDRIDES BASED ON THE δ-PHASE. Barraclough, K. G.; Beevers, C. J. (Univ. of Birmingham, Eng.). J. Mater. Sci., 4: 518-25(June 1969).

The deformation behavior of bulk polycrystalline zirconium hydrides in the composition range $ZrH_{1.27}$ to $ZrH_{1.66}$ was investigated by compressive loading at temperatures between room temperature and ~500°C. Single-phase δ-zirconium hydride is brittle below ~100°C. Analyses of slip traces on δ specimens deformed at temperatures between ~100° and ~250°C showed that the glide planes are {111} types. The deformation characteristics of δ and (δ + γ) alloys at temperatures between ~100° and ~500°C are consistent with the hydrogen vacancies in the δ-phase providing significant lattice friction to the movement of dislocations in the zirconium lattice of the hydride structure. The room temperature fracture stress of (δ + γ) alloys increases with the volume fraction of the γ-phase and this can be related to the resistance offered by γ platelets to the propagation of cleavage cracks in the δ matrix. In a (δ + γ + α) alloy the resistance to crack propagation at room temperature is further increased by the soft α-zirconium phase. (auth) (UK)

36248 COBALT-RICH PHASES IN THE TERNARY SYSTEMS COBALT–HAFNIUM–BORON AND COBALT–ZIRCONIUM–BORON. Schoebel, J.-D.; Stadelmaier, H. H. (North Carolina State Univ., Raleigh). Metall. 23: 25-7(Jan. 1969). (In German).

In the three-component systems Co–Hf–B and Co–Zr–B, the melt equilibrium and the sectional isotherm at 800°C in the Co–Hf–B system were determined. Both systems showed ternary boride phases. Compositions and crystal structures of these phases were determined. (M.C.G.)

36249 RECENT DEVELOPMENTS WITH HIGH-TEMPERATURE, HIGH-PRESSURE AUTOCLAVES FOR POWDER-METALLURGICAL PRODUCTS, ESPECIALLY HARD METALS. Ettmayer, P.; Priemer, H.; Kieffer, R. (Technische Hochschule, Vienna). Metall. 23: 307-10(Apr. 1969). (In German).

Construction details are described for high-temperature, high-pressure autoclaves and their use in studies of nitride systems discussed. Studies on Si–C–N, Cr–C–N, and U–C–N are described. (M.C.G.)

36250 SINTERED URANIUM DIOXIDE BODY. (to United Kingdom Atomic Energy Authority). French Patent 1,464,489. Filed Jan. 21, 1966.

A UO_2 ceramic containing 0.5 to 5 wt % of Y_2O_3 does not exhibit columnar grain growth when subjected to a severe temperature gradient at temperatures above 1600°C. In order to prevent grain growth at temperature between 1800 and 2000°C it is necessary to restrict the Y_2O_3 content of the ceramic preferably to 1.75 to 2.25 wt %. (NPO)

36251 CONTRIBUTION TO THE STUDY OF THE SYSTEM NIOBIUM–SULFUR. Hodouin, Daniel (Ecole des Mines, Paris). Compt. Rend., Ser. C, 268: 1943-4(June 2, 1969). (In French).

A subsulfide was found to exist in the system between 800 and 1100°C in the neighborhood of the composition NbS. (tr-auth)

36252 EVALUATION OF MICROHOMOGENEITY IN PuO_2–UO_2 FAST REACTOR FUEL BY AUTORADIOGRAPHY. Zambernard, M. J.; Seider, R. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 12: 111-12(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36253 EVALUATION OF A STATISTICAL THERMODYNAMIC METHOD FOR CALCULATING THE COMPOSITION DEPENDENCE OF CHEMICAL POTENTIALS IN NONSTOICHIOMETRIC ZIRCONIUM CARBIDE. DePoorter, Gerald L. (Los Alamos Scientific Lab., N. Mex.). J. Amer. Ceram. Soc., 52: 311-15(June 1969).

Mathematical expressions for carbon and zirconium activities in zirconium carbide are derived from a statistical thermodynamic model, on the assumption that nonstoichiometry is due to vacancies in the carbon sublattice while the zirconium sublattice remains filled. The energy term in the partition function is obtained by using a first- and second-neighbor quasi-chemical model. Values for the parameters used in the model are determined from available data as a function of composition. For C/Zr atom ratios between 0.59 and 0.85 the energy parameters are approximately composition-independent, whereas in the composition range 0.85 to 0.99 they are strongly composition-dependent. The vibrational partition functions of C and Zr in zirconium carbide are estimated and are shown to influence the value obtained for the model parameters. (auth)

36254 MELTING POINT STUDIES OF THE SYSTEM UP–US. Baskin, Y. (Argonne National Lab., Ill.); Shalek, P. D. J. Amer. Ceram. Soc., 52: 341-2(June 1969).

Results of investigations show that UP dissociates at high temperatures in open furnace experiments. Pellets heated in W capsules reacted with the W to form eutectics. For this reason measuring the melting point of UP–US solid solutions is likely to be difficult. It is estimated that UP melts at about 2850°C. (J.R.D.)

36255 TENTATIVE METHOD FOR CRYSTALLITE SIZE DETERMINATION OF BERYLLIUM OXIDE. Hirai, Toshio; Yamasaki, Nakamichi (Tohoku Univ., Sendai). J. Amer. Ceram. Soc., 52: 343(June 1969).

A method is described for use with variable thickness samples for elimination of x-ray spectral line broadening, by extrapolation. It is shown that BeO crystallite sizes can be determined from the strong x-ray diffraction reflections, measured on thick samples, by use of an experimental equation that relates the line width to sample thickness. (J.R.D.)

36256 RECRYSTALLIZATION IN THORIA-DISPERSED NICKEL SHEET. Kimmel, E. R.; Inman, M. C. (Pennsylvania State Univ., University Park). ASM (Amer. Soc. Metals), Trans. Quart., 62: 390-7(June 1969).

Recrystallization in thoria-dispersed nickel sheet has been examined as a function of strain-anneal cycles employing various degrees of cold deformation followed by heat treatment at 500 to 1300°C. Electron transmission techniques were used for quantitative determination of the degree of recrystallization. The observed percentage of recrystallized material after any chosen heat treatment regime progressively increased with increasing severity of prior cold deformation in a single cycle of strain and anneal. However, the material exhibited a remarkable resistance to complete recrystallization. The most severe strain-anneal cycle employed (80% cold reduction plus 1 hr at 1300°C), could not promote more than 80% recrystallization. Recrystallization resistance also appeared to be fortified by successive cycles of strain and anneal. Substructural examination clearly showed the presence of a banded structure where the alternate bands of recrystallized and unrecrystallized material were aligned along the original cold-rolling direction. The substructure offered no immediate explanation of the resistance to recrystallization in specific regions of the material, although it is worth noting that particle-matrix interface cavities previously proposed as grain boundary pinning points were not observed. Electron diffraction scanning of transmission specimens indicated strong alignment in localized regions (texture), but a positive correlation with recrystallization resistance has not yet been found. (auth)

36257 X-RAY INVESTIGATION OF THE TERNARY SYSTEMS V–Cr–B, Nb–Cr–B, AND Mo–Cr–B. Kuzma, Yu. B.; Telegus, V. S.; Kovalyk, D. A. (Lvov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 79-87(May 1969). (In Russian).

The binary compound Cr_5B_3 has the tetragonal structure with the lattice constants a = 5.472 ± 0.003, c = 10.098 ± 0.006 Å, c/a = 1.845. The phase equilibria in the systems V–Cr–B, Nb–Cr–B and Mo–Cr–B at 1400°C are presented. In the system V–Cr–B the continuous solid solutions VB_2–CrB_2, V_3B_4–Cr_3B_4 and VB–CrB are found; the compound Cr_5B_3 dissolves 20 at. % V and U_3B_2–15 at. % Cr. In the system Nb–Cr–B the compound NbB_2 dissolves 15 at. % Cr and Nb_3B_2–25 at. % Cr. The borides in the system Mo–Cr–B dissolve the following amounts of the third component: CrB_2–17 at. % Mo; Cr_3B_4–16 at. % Mo, CrB–40 at. % Mo, Cr_5B_3–48 at. % Mo, CrB_2–6 at. % Mo, Mo_2B–10 at. % Cr. In the systems V–Cr–B and Mo–Cr–B the ternary phases with the structures of the $CuAl_2$ type were found (for the composition $V_{0.15-0.20}Cr_{1.85-1.80}B$: a = 5.188 ± 0.004, c = 4.318 ± 0.003 Å, c/a = 0.832; for $Mo_{0.24-0.39}Cr_{1.76-1.61}B$: a = 5.215–5.245 ± 0.003, c = 4.352–4.383 ± 0.003 Å). The ternary phase (Mo, $Cr)_3B_2$ has the structure of the U_3Si_2 type (29 to 40 at. % Mo, 31 to 20 at. % Cr, 40 at. % B; a = 5.825–5.774 ± 0.003, c = 3.115–3.082 ± 0.002 Å). (auth)

36258 INVESTIGATION OF CHANGES IN THE STRUCTURE OF WC–Co ALLOYS AT PLASTIC DEFORMATION. Chaporova, I. N.; Pivovarov, L. E.; Ivensen, V. A.; Eiduk, O. N.; Sultanyan, T. A.; Varaksina, A. V.; Korotkova, R. F.; Chistyakova, V. A. (All-Union Scientific-Research Inst. of Hard Alloys, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 63-8(May 1969). (In Russian).

The deformation development in carbide and cobalt phases of BK6 and BK50 alloys under loadings close to yield limit is described. During electron-microscopic investigation the slip bands are found in the carbide phase under stresses close or equal to the yield limit in both low-cobalt alloy BK6 and high-cobalt one—BK50. The latter is explained by the uniformity of its structure—the presence of continuous contacts between the grains of WC–WC. (auth)

36259 NEW COMPOUNDS IN THE SYSTEMS OF Pr_2O_3–SrO AND Nd_2O_3–SrO. Lopato, L. M.; Pavlikov, V. N.; Lugin, L. I. Dopov. Akad. Nauk Ukr. RSR, Ser. B., No. 5, 429-31(May 1969). (In Ukrainian).

New compounds of 2:1, 4:5 and 1:2 composition are synthesized in the systems Pr_2O_3–SrO and Nd_2O_3–SrO. The temperature limits of stability and x-ray characteristics of the compounds are determined. (auth)

36260 MICRO REFLECTION MEASUREMENTS ON SINTERED SAMPLES OF Ti–TiN–TiC AND Zr–ZrN–ZrC. Knosp, Helmut; Goretzki, Hans (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 60: 587-94(July 1969). (In German).

Reflectivities of specimens within the homogeneity region of the refractory compounds Ti–TiN–TiC and Zr–ZrN–ZrC are measured in the spectral range between 275 and 900 nm. Extended similarities in the optical properties of both systems are evident. The reflectivity of the nitrides and of the nitride-rich compounds in the near infrared is caused by free electrons. For the carbides and the carbon-rich compounds quantum absorption dominates over the entire measured spectral range. (auth)

36261 SOME OBSERVATIONS ON THE Pu–Zr–O SYSTEM. Mardon, P. G.; Hodkin, D. J.; Dalton, J. T. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 32: 126-34(Aug. 1969).

Constitutional studies on samples with oxygen/metal ratios $1.61 < O/M < 2.00$ have shown that the stabilization by PuO_2 of cubic ZrO_2 to room temperature, as observed by previous workers, is related to reduced oxides on the $PuO_{1.61}$–ZrO_{2-x} tie. In the fully oxidized state, tetragonal ZrO_2 is stabilized over a wide range of PuO_2 contents at high temperatures while at lower temperatures the solubility of PuO_2 in the tetragonal phase appears to pass through a maximum at about 1,000°C and then decreases rapidly, leaving a wide 2-phase region of PuO_2-rich cubic (Pu,Zr)O_2 plus ZrO_2-rich tetragonal (Pu,Zr)O_2. In PuO_2-rich samples there is evidence of the existence of fluorite, C-type rare earth oxide and pyrochlore structures at different oxygen/metal ratios. (auth)

36262 HEATING EXPERIMENTS WITH (Th/U)O_2 PARTICLE FUELS FOR A FUEL ROD-LIKE TEMPERATURE DISTRIBUTION. Neeb, K. H.; Peehs, M. (Kerntechnische Laboratorien der Siemens AG, Erlangen, Ger.). J. Nucl. Mater., 32: 174-7 (Aug. 1969). (In German).

It is noted that the use of fuel elements composed of compacted ThO_2–UO_2 fuel particles coated with zircaloy is advantageous. In development of such fuel, geometric stabilization of particles and distribution of U during thermal processing are factors to be considered. Developmental heating experiments conducted using such particles are described. Results indicate that particles can be produced by heating at 2500°C for two hours in a fluidized bed thereby promoting particle structure rearrangement to a stable phase incorporating a protective zone. (J.R.D.)

36263 THERMAL EXPANSION OF CERMETS CONTAINING URANIUM DIOXIDE. Tummala, R. R.; Friedberg, A. L. (Univ. of Illinois, Urbana). J. Nucl. Mater., 32: 178-80(Aug. 1969).

Equations useful in prediction of the thermal expansion of multiphase materials such as UO_2–stainless steel and UO_2–Mo cermets are presented. (J.R.D.)

36264 STUDIES ON THE U–C CONSTITUTIONAL DIAGRAM BETWEEN UC AND UC_2. Sears, M. B.; Ferris, L. M. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 32: 101-12(Aug. 1969).

The U–C system from $UC_{1.0}$ to $UC_{2.4}$ (4.8 to 10.8 wt % carbon), with major emphasis on the region between 1820 and 1275°C, was studied by identifiying the phases present in arc-cast and heat-treated specimens that had been cooled to room temperature. Uranium sesquicarbide was found to have a line composition very close to $UC_{1.50}$ and an upper stability limit of about 1800°C. Below 1800°C, the uranium monocarbide lattice accommodated a maximum of about 1.02 carbon atoms per uranium atom. The dicarbide phase existed over a much wider composition range, from about $UC_{1.7}$ to $UC_{1.9}$ at 1765°C; this range narrowed as the temperature decreased. The maximum carbon content of the cubic dicarbide phase decreased with temperature from 1.89 carbon atoms per uranium atom at the melting point to a minimum of 1.85 at about the cubic-to-tetragonal transformation temperature. Combined-carbon/uranium atom ratios above 1.85 could be obtained at room temperature only by quenching specimens containing less than 0.2 wt % free carbon because the free carbon acted as precipitation centers in the metastable solutions. When cooled from the cubic to the tetragonal region, the dicarbide disproportionated into monocarbide and a tetragonal dicarbide that had an estimated composition of $UC_{1.89}$ at room temperature. No thermal decomposition of the tetragonal uranium dicarbide was observed after heat-treatment at 1260 to 1600°C. (auth)

36265 THERMODYNAMICS OF MULTI-COMPONENT SYSTEMS CONTAINING UC AND PuC. A REVIEW. Holleck, H.; Kleykamp, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 32: 1-19(Aug. 1969).

Isothermal and concentration sections of the phase diagrams of ternary and quaternary systems U–M–C, Pu–M–C, U–Pu–M–C, U–M_1–M_2–C, and Pu–M_1–M_2–C are described. The miscibility of UC and PuC with other binary carbides is discussed and the free enthalpies of mixing are given. The ternary and quaternary carbides and their lattice constants are compiled. The free enthalpies of formation of these compounds are estimated from the phase diagrams. (auth)

36266 PROPERTIES OF VACANCIES IN URANIUM CARBIDE. Schuele, W.; Spindler, P. (EURATOM–CCR, Ispra, Italy). J. Nucl. Mater., 32: 20-9(Aug. 1969).

A vacancy formation energy of 1.0 ± 0.1 eV and a migration activation energy of 1.45 ± 0.3 eV were determined in UC which are attributed to C-vacancies. It is shown that in uranium carbide the migration of C- and U-vacancies occurs very likely in the sublattices of carbon and uranium, respectively. For U-vacancies a formation energy between 1.4 and 1.7 eV and a migration activation energy of 2.2 eV are estimated. It is concluded that in the lower temperature range (<1400°C) the diffusion rate of carbon is determined by a single vacancy diffusion mechanism and in the higher temperature range (>1400°C) by a divacancy diffusion mechanism in the carbon sublattice. The diffusion of U-atoms is assumed to be determined by a single vacancy mechanism in the uranium sublattice in the entire temperature range investigated. (auth)

36267 PHASE RELATIONSHIPS IN THE $\alpha + \delta$ REGION OF THE Zr–H SYSTEM. Moore, K. E. (Atomics International, Canoga Park, Calif.). J. Nucl. Mater., 32: 46-56(Aug. 1969).

The $(\alpha + \delta)/\delta$ phase boundary of the Zr–H system has been defined on the basis of studies performed on zirconium hydrides containing 4 at. % U. The methods used include optical hot stage microscopy and room-temperature metallography, dilatometry, and x-ray diffraction. This boundary was found to exist between about 1.33 H/Zr at 550°C and 1.60 H/Zr at 25°C. A metastable phase, γ' coexisting with α and δ phases, was found to transform to δ at about 294°C between 1.20 H/Zr and the $(\alpha + \delta)/\delta$ boundary (1.50 H/Zr). (auth)

Radiation Effects

Refer also to abstracts 36169, 36232, 37541, and 37625.

36268 (AECL–3294) THERMAL CONDUCTIVITY OF ThO_2–PuO_2 UNDER IRRADIATION. Jeffs, A. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr. 1969. 40p. Dep. CFSTI. CAN $1.00.

ThO_2–PuO_2 fuels are of interest as the possible first charge of reactor systems utilizing the ^{232}Th–^{233}U cycle. An important parameter of any fuel is its thermal conductivity under service conditions and this has been measured at low exposures for sintered fuel of 96.5% T.D. using an instrumented fuel rod. The results show that up to the maximum temperature recorded in this test, 1630°C, the integrated thermal conductivity of thoria-based fuels is improving steadily with increasing temperature, relative to that of UO_2. At the highest temperature of measurement the difference is about 25%. (auth)

36269 (AECL–3295) IRRADIATION DAMAGE IN U_3Si. MacEwan, J. R.; Bethune, B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr. 1969. 21p. (CONF-690620–2; SM–120/H-3). Dep. CFSTI. CAN $1.00.

From Symposium on Radiation Damage in Solids and Reactor Materials, Vienna, Austria.

The ordered body-centered tetragonal structure of U_3Si transforms allotropically or by irradiation damage to ordered and disordered face-centered cubic structures respectively. An exposure of about 6×10^{16} fissions/cm^3 at 100°C produced x-ray diffraction patterns of the cubic form with a 0.6% decrease in x-ray density. However, immersion density measurements showed a volume increase of 2.3% at a similar exposure. Further irradiation removed all but two peaks from the diffraction pattern indicating a trend to an amorphous structure. Electric resistivity measurements showed that U_3Si is an electronic conductor with a large positive temperature coefficient. Measurements made below the irradiation temperature of 100°C showed that the temperature coefficient decreased with irradiation and approached zero at high

exposure. Amorphous materials have a negligible temperature coefficient, so the result confirms the trend observed by x-ray analyses. (auth)

36270 (EUR-4255) CRAYON G1: A CODE FOR THE CALCULATION OF THE IRRADIATION BEHAVIOR OF FUEL RODS. Fantozzi, M.; Huber, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 28, 1969. 43p. Dep.

The code CRAYON G1 is used to calculate the evolution of the characteristics of a cylindrical gas-bonded fuel rod during irradiation such as fuel temperature and swelling, fission gas release and pressure, sheath stress, and sheath strain. The relations utilized in the code are reported. For the ORGEL fuel element (SAP-clad uranium carbide), material properties, being input data for the code, are given. The constants concerning the irradiation behavior of uranium carbide have been adjusted by application of the code to the irradiation experiment NRX-721. (auth)

36271 (WAPD-TM-758) THE IN-PILE THERMAL CONDUCTIVITY OF SELECTED ThO_2–UO_2 FUELS AT LOW DEPLETIONS (LWBR DEVELOPMENT PROGRAM). Jacobs, D. C. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1969. Contract AT(11-1)-Gen-14. 62p. Dep. CFSTI.

The in-pile thermal conductivities of selected ThO_2-UO_2 fuel materials were determined by direct measurement using an in-pile extension of the radial heat-flow technique. The tests incorporated ThO_2 + 3.1 wt % UO_2, ThO_2 + 7.7 wt % UO_2, ThO_2 + 10 wt % UO_2, and UO_2 specimens. The microstructure, stoichiometry, density, impurity content, and unirradiated thermal conductivity were determined for each fuel material. The test results showed no statistically significant differences between the in-pile and unirradiated thermal conductivities for steady-state operation for the UO_2 specimens at $600 \leq T \leq 1000°C$, at a burnup of up to 5.6×10^{18} fission/cm^3 and for the ThO_2-UO_2 specimens at at $400 \leq T \leq 1000°C$ at a burnup of up to 1.4×10^{19} fission/cm^3. The in-pile conductivities were slightly, but significantly, greater than the unirradiated conductivities at $1000 < T \leq 1300°C$ for the UO_2 specimens and at $1000 < T \leq 1700°C$ for the ThO_2-UO_2 specimens. However, this is considered to be an experimental anomaly and is not taken as a meaningful enhancement of in-pile conductivity. The maximum depletions achieved in these tests are one to two orders of magnitude less than typical in-service depletions. Hence, the test results dc not reflect any possible changes in conductivity by the accumulation of fission products and the formation of fission gas bubbles. (auth)

36272 EVAPORATION OF UO_2 CONTAINING Pu NUCLIDES FORMED DURING IRRADIATION. Doi, Akira; Kobayashi, Tadao; Inoue, Kiyoshi (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 6: 322-5(June 1969).

Evaporation of UO_2 containing Pu nuclides formed during irradiation is discussed on the basis of data from the mass spectrometry of UO_2 specimen irradiated to about 8,000 MWd/t burnup. It was found that the ratio between Pu^+ and U^+ ion currents obtained from the vaporization-ionization process of the UO_2 specimen was greater than the corresponding ratio of atoms present in the specimen and that in temperature dependency, the U^+ ion current followed that of the UO_2 vapor pressure, but no such correspondence was seen between the Pu^+ ion current and the PuO_2 vapor pressure. (auth)

36273 INTERNAL FRICTION STUDY OF ANNEALING PROCESSES IN PILE-IRRADIATED GRAPHITE. Saito, M.; Baba, M.; Kawamura, K.; Tsuzuku, T. (Nihon Univ., Tokyo). Carbon, 7: 379-84(June 1969).

A reactor grade graphite irradiated by fast neutrons at 30°C to the total dose of 5.8×10^{20} nvt was stepwise annealed between 100 and 2300°C, and was examined each time by measuring the internal friction and dynamic modulus at temperatures from 300 down to 80°K. The recovery process was found to consist of three stages, the first stage occurring between 100 and 500°C, the second stage in the range from 600 to 1150°C, and the third stage between 1200 and 2300°C. In the first stage the dynamic modulus largely recovered, while the internal friction indicated little change. Recovery of internal friction occurred mostly in the third stage, where the dynamic modulus showed only a slight fall-off. In the second stage there was no serious change in the anelastic properties. A qualitative explanation for the formation and decomposition processes of interstitial clusters is given within the framework of the Granato–Lücke theory in relation to the behavior of such anelastic properties. (auth) (UK)

36274 DYNAMIC MECHANICAL BEHAVIOR OF STRESS-GRAPHITIZED PYROLYTIC CARBON FOLLOWING REACTOR IRRADIATION AT 77°K. Blankenhorn, P. R.; Kline, D. E. (Pennsylvania State Univ., University Park). Carbon, 7: 345-54(June 1969).

Stress-graphitized pyrolytic carbon specimens were subjected to reactor irradiation ($\sim 10^{15}$ nvt–fast) while their temperature was maintained near 77°K. The specimen temperature was subsequently held near 77°K while the specimens were transferred into a testing apparatus where the dynamic mechanical properties were obtained as a function of temperature from 80 to 750°K. First tests between 100 and 300°K revealed an inverse annealing effect in the dynamic elastic modulus, with an inflection near 160°K. Internal friction peaks at 180 and 240°K were also observed in this temperature region. Following annealing of the specimens to 300°K, results for both the internal friction and the elastic modulus changed, compared to the first post-irradiation run. The dynamic mechanical behavior from 100 to 750°K, appeared to be similar to results previously reported by Taylor, Kline and Walker for room temperature irradiations. This included a large inverse annealing peak in the elastic modulus centered slightly above 500°K. (auth) (UK)

36275 HIGH TEMPERATURE FAST-NEUTRON IRRADIATION OF PYROLYTIC-CARBON-COATED ThO_2 MICROSPHERES. Hewette II, D. M. (Oak Ridge National Lab., Tenn.). Carbon, 7: 373-8(June 1969).

The effects were determined of fast-neutron damage alone on four types of pyrolytic-carbon coatings with spherical geometry. The coatings, which ranged in density from 1.75 to 2.07 g/cm^3, and had Bacon anisotropy factors from 1.0 to 1.4, were irradiated in the Dounreay Fast Reactor to 4.5×10^{21} neutrons/cm^2 (>0.18 MeV) at about 1200°C. A porous buffer layer prevented interaction between the coating and the sol-gel ThO_2 kernels. Essentially no fissioning occurred in the ThO_2 in the fast-neutron spectrum. Only the coatings with the highest anisotropy factor failed. Coatings with an initial density of 1.8 g/cm^3 or less densified, while coatings with initial density of 1.9 g/cm^3 or greater swelled. Metallographic examination revealed that the preferred orientation increased in the coatings that densified. (auth) (UK)

36276 URANIUM–PLUTONIUM MIXED-OXIDE SOL-GEL IRRADIATION EXPERIMENTS. Cogliati, G.; Lepscky, C.; Rotoloni, P. L.; Testa, G.; Trezza, G. (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). Trans. Amer. Nucl. Soc., 12: 105-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36277 A QUANTITATIVE EVALUATION OF FISSION-INDUCED POROSITY IN IRRADIATED UN. Markworth, Alan J. (Battelle Columbus Labs., Ohio). Trans. Amer. Nucl. Soc., 12: 204-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36278 POSTIRRADIATION EXAMINATION OF 20 WT. PERCENT PuO_2–UO_2 IRRADIATED TO 100,000 MWd/TONNE. Caldwell, C. S.; Miles, J. F.; Ross, W. J. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 12: 112-13(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36279 IN-PILE AND OUT-OF-PILE CREEP OF UO_2 AND UO_2–PuO_2. Keller, D. L.; Perrin, J. S.; Robinson, R. A.; Basham, S. J. Jr. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 108-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36280 PERFORMANCE OF MIXED-OXIDE FUEL ELEMENTS WITH CENTER MELTING. Brown, F. L.; Neimark, L. A.; Murphy, W. F.; Natesh, R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 107-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36281 MECHANISM CAUSING HYDRIDE DEFECTS AT END-CAP WELDS OF ZIRCALOY-SHEATHED UO_2. Bain, A. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 12: 99-100(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36282 FAST-NEUTRON STABILITY OF REFRACTORY METAL CARBIDES AT HIGH TEMPERATURES. Keilholtz, G. W.; Moore, R. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 101-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36283 PERFORMANCE IN EBR-II OF CARBIDE FUEL ELEMENTS IRRADIATED TO 7 AT. PERCENT BURNUP. Latimer, T. W.; Brown, F. L.; Neimark, L. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 87-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36284 SWELLING BEHAVIOR OF VIBRATORILY COMPACTED MIXED CARBIDES. Michels, L. C.; Neimark, L. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 88-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36285 INITIAL RESULTS ON THE IRRADIATION BEHAVIOR OF SODIUM-BONDED (U,Pu)C FUELS. Harbourne, B. L.; Levine, P. J.; Biancheria, A. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 89(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36286 FISSION PRODUCT PROFILES IN GRAPHITE EXPOSED TO FISSIONING ^7LiF–BeF_2–ZrF_4–UF_4. Cuneo, D. R.; Robertson, H. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 80-1(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36287 FISSION GAS BUBBLES IN URANIUM CARBIDE. Oi, N. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Trans. Amer. Nucl. Soc., 12: 77-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36288 SWELLING OF UO_2 AT 1700°C. Storhok, V. W.; Chubb, W. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 12: 76(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36289 STRUCTURE OF ION-IMPLANTED GOLD LAYERS IN SINGLE-CRYSTAL SILICON. Matthews, M. D.; James, P. F. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 19: 1179-88(June 1969).

By implanting 30 to 50 keV gold ions into silicon high concentrations of gold (approaching 20 at. %) were produced in shallow (~200 Å) surface layers. Implantations were usually carried out at room temperature and electron microscopy was used to study the structure of implanted layers as a function of heat treatment, which anneals the lattice damage created during implantation. For moderate doses (~10^{16} ions/cm^2) the amorphous surface produced during implantation annealed by an epitaxial process at ~630°C, but defects in the form of microtwins and other planar defects remained. For the highest doses (~10^{17} ions/cm^2) the eutectic nature of the Si–Au system was manifest in giving improved recrystallization at somewhat lower temperatures and at the same time widespread surface gold precipitation occurred. In certain areas an f.c.c. Si–Au phase was also formed. (auth)

36290 IRRADIATION-INDUCED DIMENSIONAL CHANGE IN BORON CARBIDE. Stansfield, O. M. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. J. Nucl. Mater., 31: 351-5(July 1969).

The swelling of spheroidal B_4C particles was studied at high ^{10}B burnup for a restrained and an unrestrained condition. The B_4C spheres of about 200 μm diameter, both uncoated and coated with 100 μm-thick pyrocarbon (PyC), were irradiated in the Engineering Test Reactor at 500°C for 2300 hours with 2.7 and 1.5×10^{21} n/cm^2 and to a ^{10}B burnup of 78%. The uncoated spheres expanded in diameter from 5 to 15% while the B_4C spheres coated with PyC were restrained from swelling by the coating and did not change dimension. The PyC tended to shrink around the B_4C so that the PyC outside diameter decreased about 4%. (G.M.C.)

36291 FISSION GAS BUBBLES IN FRACTURED UO_2 CHIPS. Katz, O. M. (Bettis Atomic Power Lab., West Mifflin, Pa.). J. Nucl. Mater., 31: 323-6(July 1969).

High-density UO_2 was irradiated between 3.8 to 24.9×10^{20} fissions/cm^3 at temperatures below 870°C and the bubble characteristics of the UO_2 chips were examined by transmission electron microscopy. An increase from 3.8 to 14.0×10^{20} fissions/cm^3 resulted in slightly larger bubbles both before and after the in-microscope heating conditions. The fission gas content in the bubbles increased after heating. Retention of fission gas in solution decreased at higher burnups. An inert gas atom diffusion coefficient of 4.8×10^{-16} cm^2/sec was obtained for the 24.9×10^{20} fissions/cm^3 UO_2 chip. A model for bubble growth was proposed. (G.M.C.)

36292 EFFECT OF NEUTRON IRRADIATION ON ELECTRIC RESISTANCE AND COLOR OF REFRACTORY COMPOUNDS. Ogorodnikov, V. V.; Kovalchenko, M. S.; Krainii, A. G. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 88-92(May 1969). (In Russian).

An increase in the electric resistance of the irradiated titanium and chromium carbides is shown to be connected with the displacement of atoms in the lattices of these compounds. The increment of the electric resistance is in a linear dependence on the effective temperature characterizing the lattice expansion which is connected with the accumulation of radiation defects. A change in color of irradiated lanthanum hexaboride evidences for the change in its electronic structure caused by both the local distortions of the lattice and its expansion as a whole. (auth)

Plastics and Other Materials

Refer also to abstracts 35383, 35437, 37448, 37498, 37500, and 37535.

36293 (EUR-4190, pp 383-401) SHEAR EXPERIMENTS IN PEBBLE BEDS. Brauns, J. (Karlsruhe Univ. (West Germany). Institut fuer Bodenmechanik und Felsmechanik). (In German).

The results of experimental and theoretical investigations on regular packings of equi-radii spheres under homogeneous, exterior, and principal stress conditions are discussed. The problems studied are: principal stress ratio at failure of sphere packings under triaxial and plane strain conditions; the behavior of sphere packings in one-dimensional compression; shear strength under plane strain conditions with respect to stability properties; and critical stress ratio under triaxial conditions with respect to crushing of spheres. The radical simplification of using regular sphere packings for a granular mass permitted an extensive analytic handling of these problems without requiring assumptions about essential mechanical properties. The investigations are limited to sphere packings under static loading conditions. (auth)

36294 (EUR-4190, pp 423-36) CHARACTERIZATION OF PACKINGS. Schoenert, K. (Karlsruhe Univ. (West Germany). Institut fuer Mechanische Verfahrenstechnik). (In German).

Packings of grains of different sizes are characterized by bulk density, size distribution, and arrangement of elements. These qualities are usually dependent on the locus. The bulk density can be described by the term $(1 - \epsilon)$. The characterization of size distribution is necessary because of segregation effects. The determination of size distributions is more complicated than the measurement of bulk densities. If no segregation exists only statistical deviations may occur. It is necessary to recognize by statements on the grain arrangements whether a regular or an irregular packing exists. In the case of an irregular packing it is of special interest whether a homogeneous statistical arrangement exists or not. To investigate such arrangements it is useful to cut the packed grains. Regular arrangements can be recognized because of their periodical pattern. Following Wicksell, the homogeneous statistical arrangement relations between the measurable quantities of the cut and the packed grains can be obtained. The validity of these relations is a necessary condition for homogeneous statistical arrangements. A further necessary condition is the equivalence of volume porosity ϵ_V and area porosity ϵ_F. In case of non-spherical grains relations like these of Wicksell are difficult to find. It is relatively easy to give an equation for the mean value of the cuts. Here also the relation $\epsilon_V = \epsilon_F$ exists as a necessary condition. (auth)

36295 IRRADIATION EXPERIENCE WITH ISOTROPIC GRAPHITE. Nettley, P. T. (United Kingdom Atomic Energy Authority, Culcheth, Eng.); Brocklehurst, J. E.; Martin, W. H.; Simmons, J. H. W. pp 603-16 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The use of isotropic graphites with high coefficients of thermal expansion for the moderator of an AGR was first recommended just over five years ago. Since that time wide experience of the irradiation behavior of such graphites has been gained from experiments performed mainly in the Dounreay Fast Reactor (DFR) and in the Belgian reactor BR-2. The data obtained for five isotropic graphites on dimensional changes, irradiation creep, changes in thermal conductivity, thermal expansion, Young's modulus and strength are presented. The effect of radiolytic oxidation in CO_2 coolant on these properties is also discussed. Linear dimensional changes induced by fast-neutron irradiation in an AGR moderator, made from any of the isotropic graphites

studied here, would be less than 3.5% during the lifetime of an AGR of the Dungeness "B" type. Molded isotropic graphite exhibits less shrinkage than extruded isotropic graphite. The irradiation creep behavior of the isotropic graphites ensures that internal stresses in AGR bricks resulting from the irradiation-induced dimensional changes will be small. The strength of the AGR moderator graphite is increased by fast-neutron irradiation and decreased by radiolytic oxidation. The strength of the moderator at the end of life will not be less than the original value if radiolytic weight losses are less than 13%. At neutron damage doses slightly higher than the expected peak lifetime dose of an AGR moderator of the Dungeness "B" type, a marked temperature dependence is observed in dimensional changes in the temperature range 370 to 550°C in DFR, and a rapid growth is observed at these high doses in all materials investigated at temperatures of 500 to 550°C. 26 references. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Stars

Refer also to abstracts 36358, 36488, 36489, 36535, and 36696.

36296 THE NATURE OF THE VARIABILITY OF HD 19216. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 156: 175-6 (June 1969).

Stepien (1969) recently reported that HD 19216, chosen by chance as a photometric comparison star for 21 per, itself appears to be a variable star of small range with a period of 7.7d. Examination of two spectrograms with a dispersion of 9 Å mm^{-1} of HD 19216 obtained in August 1968 with the Palomar coudé confirm that any spectral peculiarities present are indeed subtle. (W.D.M.)

36297 THE MAGNETIC FIELD OF HD 215441. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 156: 967-82 (June 1969).

Zeeman spectrograms of HD 215441 show evidence for a periodic variation of its magnetic field in 1967. Comparison of intensities and displacements of the Zeeman components resolved on high-dispersion spectrograms with those calculated for inclined dipoles indicate that the magnetic field of HD 215441 is not dipolar. Calculations for other simple, arbitrary geometries suggest the nature of the departures from dipole geometry. (auth)

36298 ROTATIONAL VELOCITIES IN THE OPEN CLUSTER NGC 6475 (M7). Abt, Helmut A. (Kitt Peak National Observatory, Tucson, Ariz.); Jewsbury, Clifford P. Astrophys. J., 156: 983-8 (June 1969).

The cluster NGC 6475 (M7) is found to have the following distinctive characteristics: (1) a very low mean rotational velocity among its B6–B9.5 stars; (2) several Ap stars; (3) an unusually high mean rotational velocity among its A1–A3 stars; and (4) a possible separation between sharp- and broad-lined stars in its H–R diagram. (auth)

36299 PRESSURE-INDUCED OPACITY OF MOLECULAR HYDROGEN IN LATE-TYPE STARS. Linsky, Jeffery L. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 156: 989-1005 (June 1969).

The pressure-induced opacity resulting from binary collisions of hydrogen molecules with each other and with helium atoms is computed for temperatures typical of the photospheres of late-type stars. The opacity is effectively continuous throughout the infrared, and consists of overlapping translational, rotational, and vibrational transitions in the hydrogen molecule. For temperatures less than roughly 2500°K, depending on the pressure, this should be the primary source of continuous opacity in stellar photospheres between the wavelengths of 1 and 10 μ. Algorithms are given for this opacity that are useful in calculations of stellar atmospheres. (auth)

36300 CURVE-OF-GROWTH ANALYSIS FOR THE CLOSE BINARY HR 5317. Kondo, Yoji (Goddard Space Flight Center, Greenbelt, Md. Kitt Peak National Observatory, Tucson, Ariz.); McCluskey, George E. Jr. Astrophys. J., 156: 1007-12 (June 1969).

The single-lined spectroscopic binary HR 5317 was observed with a dispersion of 13.5 Å mm^{-1} at the coudé focus of the 84-inch reflector of the Kitt Peak National Observatory. The strength of the Balmer lines indicates a spectral type no later than F6, while the metallic lines give a spectral type of F8 or later. A curve-of-growth analysis was carried out. The results indicate that the elements Mg, Mn, Ca, and Sr are over abundant with respect to the standard star 110 Her. The results are somewhat dependent on the adopted luminosity class for HR 5317. (auth)

36301 SPECTROSCOPIC BINARIES AND COLLAPSED STARS. Trimble, Virginia L. (California Inst. of Tech., Pasadena. Inst. of Theoretical Astronomy, Cambridge, Eng.); Thorne, Kip S. Astrophys. J., 156: 1013-19 (June 1969).

Lists are given of single-line, spectroscopic binaries with large mass functions. The absence of a secondary spectrum in these systems could, in principle, result from the secondary star's being either a collapsed star or a massive neutron star. For all these systems, however, other explanations are possible in the light of present observations. Statistical considerations suggest that few, if any, of the systems in these lists contain collapsed or neutron-star secondaries. None of these binary systems coincide with any published x-ray source position. (auth)

36302 EVOLUTION OF INITIALLY PURE ^{12}C STARS AND THE PRODUCTION OF PLANETARY NEBULAE. Kutter, G. S.; Savedoff, M. P. (Univ. of Rochester, N. Y.). Astrophys. J., 156: 1021-49 (June 1969).

The evolution of stellar models composed initially of ^{12}C was followed by the Henyey method, as an approximation to the cores of evolved stars. It was found that the lower mass limit for ^{12}C-ignition is 1.08 $M_\odot$. Between 1.08 and 1.58 $M_\odot$ the stars ignite ($\epsilon_{CC} > \epsilon_\nu$) in an electron-degenerate shell, while stars above 1.58 $M_\odot$ ignite centrally. During the shell flash for $1.08 \leq M/M_\odot \leq 1.58$, which lasts about 500 years, the total stellar energy increases by about 30%; but there is no indication of mass loss. In stars below approximately 1.2 $M_\odot$, flash expansion quenches ^{12}C shell burning, whereas above 1.2 $M_\odot$ the star expands until nuclear gains and neutrino losses balance. In the latter stars the shell burning advances to within less than 0.2 $M_\odot$ of the surface, driving the optical luminosity to $\simeq 10^5$ $L_\odot$. Near this value, the divergence of the pressure becomes greater than the gravitational-body force. The surface layers thus appear to become unbound, and this is suggested as a possible mechanism for the production of planetary nebulae. The approximate agreement between the theoretical results and the observational data tends to support this connection. (auth)

36303 DIFFERENTIAL ROTATION IN STARS ON THE UPPER MAIN SEQUENCE. Clement, Maurice J. (Univ. of Toronto). Astrophys. J., 156: 1051-68 (June 1969).

Models for slowly rotating stars on the upper main sequence are constructed without radiation pressure. The well-known indeterminancy in the distribution of stellar angular momentum is removed by applying either of two supplementary boundary conditions which are due to the circumstance that radiative viscosity and the radiative transport of angular momentum are relatively large in the outer envelopes of luminous stars. For all the models, the angular velocity at the surface is smaller than the constant value in the rigidly rotating, convective core. One of the extra boundary conditions gives rise to a small equatorial acceleration at the outer boundary, whereas the other requires a strong equatorial deceleration, the angular velocity at the equator in the latter case being as small as 6% of the central value. In the interior, surfaces of constant angular momentum per unit mass are approximately cylindrical, a circumstance which favors the stability of these solutions. (auth)

36304 EFFECT OF QUANTUM CORRELATIONS ON ELECTRON-SCATTERING OPACITIES. Diesendorf, M. O. (Imperial Coll. of Science and Tech., London); Ninham, B. W. Astrophys. J., 156: 1069-73 (June 1969).

The effect of quantum free-electron correlations on the Thomson cross section for the scattering of electromagnetic radiation in stellar interiors is investigated. It is shown that, although quantum correlations lead to insignificant corrections in the case of hot diffuse stars where electron scattering completely dominates the opacity, they are not negligible in the interior of the Sun and of similar stars. (auth)

36305 IONIZATION STRATIFICIATION AND CHEMICAL ABUNDANCES IN THE PLANETARY NEBULA NGC 7662. Harrington, J. Patrick (Univ. of Maryland, College Park). Astrophys. J., 156: 903-14 (June 1969).

Models were constructed with parameters chosen to represent the planetary nebula NGC 7662. It was found that good agreement can be obtained between the observed and the calculated forbidden-line intensities if the following abundances are chosen: O/H = 4.5×10^{-4} and Ne/H = 5.5×10^{-5}. The influence of density fluctuations on the [N(II)] and [O(II)] lines is discussed. If the permitted lines of O(III) and O(IV) are interpreted as recombination lines, the results are completely incompatible with these models. This lends support to Seaton's hypothesis that absorption of stellar radiation by the spectral lines is a more important mechanism. (auth)

36306 THE GLOBULAR CLUSTERS NGC 2808 AND NGC 1851. Alcaino, Gonzalo Astrophys. J., 156: 853-9 (June 1969).

A UBV photoelectric investigation on the previously unre-

searched southern globular clusters NGC 2808 and NGC 1851 was carried out at the Cerro Tololo Inter-American Observatory with the 16-inch and 36-inch reflectors. Fifty stars in NGC 2808 were observed an average of 1.7 times to apparent magnitude V = 15.3, and forty-eight stars in NGC 1851 were observed an average of 2.4 times to magnitude V = 15.7. At V = 15.7 the 36-inch was used to the limit of the instrumentation in spite of excellent photometric conditions. On NGC 2808 it was not possible to reach the horizontal branch in the color–magnitude diagram. On NGC 1851 four stars are suspected of belonging to the horizontal branch from their position in the C – M diagram at V = 15.65. The reddening of NGC 2808 is estimated to be E(B – V) = 0.28. The apparent visual distance modulus is $(m - M)_{app}$ = 15.85, the true distance modulus is $(m - M)_0$ = 15.01 if the visual absorption is $A_V = 3E(B - V)$. The distance is 10 kpc. On NGC 1851 the reddening is estimated to be E(B – V) = 0.24. The apparent visual distance modulus is $(m - M)_{app}$ = 15.15, the true distance modulus is $(m - M)_0$ = 14.43. The distance is 7.69 kpc. (auth)

36307 ABSOLUTE gf-VALUES FOR Fe I AND Fe II LINES. Grasdalen, Gary L.; Huber, Martin; Parkinson, W. H. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 156: 1153-73(June 1969).

Absolute gf values for 34 lines of Fe I and 12 lines of Fe II were measured between 3190 and 3315 Å, and for the Fe I lines coefficients of van de Waals broadening were also determined. The spectra were taken in absorption through a shock-heated gas containing Fe and were photographed with a 3-m spectrograph. These measurements and those of Huber and Tobey suggest that the absolute scale of Corliss and Warner for Fe I is approximately 1.0 dex too high for lines below 4000 Å. Consideration of the relative and absolute scales of published gf values has indicated a wavelength dependence in the NBS values between 4000 and 5000 Å. However, for lines above 5000 Å, conclusive proof that the scale is in serious error was not found. (auth)

36308 THE ATMOSPHERE OF α SERPENTIS. I. PRELIMINARY CURVE-OF-GROWTH ANALYSIS. Griffin, R. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 143: 223-9(1969).

The spectrum of the strong-CN K2 III star α Ser was investigated in the region 5640 to 6320 Å and compared with Arcturus (K2 III). Accurate differential curves of growth for α Ser yield metal abundance ratios (relative to hydrogen) that are about five times as great as in Arcturus and, with less certainty, nearly twice as great as in the Sun. (auth) (UK)

36309 THE OB STARS IN CARINA–CENTAURUS. Feinstein, A. (Observatorio Astronomics, La Plata). Mon. Notic. Roy. Astron. Soc., 143: 273-87(1969).

In the Carina–Centaurus region 135 OB stars with known spectral type and luminosity class were observed photoelectrically in the UBV system. Around the peculiar object η Carinae 50 stars were also measured. Many of them are probably connected with the open cluster Tr 16. The observations suggest that all the very high luminosity OB stars are farther from the Sun than 1600 pc. There also seems to be no limit in their depth distribution since, at more than 6000 pc, very bright stars are still appearing. On the other hand the distance of the open cluster Tr 16 is around 2500 pc. With the observed reddening for the clusters Tr 16 and IC 2944, and adopting a ratio of total to selective absorption of R = 3, a mean absorption per kiloparsec of about a_v = 0.5 m kpc^{-1} is found, which is a very low value for the galactic plane. (auth) (UK)

36310 COMPARATIVE STUDY OF MOTIONS FOR NEARBY STARS OF VARIOUS LUMINOSITY IN CONNECTION WITH PROBLEMS OF STELLAR EVOLUTION. Martinet, Louis; Mayor, Michel (Geneva Observatory). Astron. Astrophys., 1: 19-27(Jan. 1969).

Stellar samples, the kinematic properties of which are similar to those of A stars, were investigated. The existence of such samples does question the validity of applying the stellar hydrodynamics equations in their classical form to problems of local dynamics. Here, the variations of kinematic parameters such as eccentricity, vertex deviation etc., are particularly shown for the nearby giants in terms of their location in the HR diagram. The results may be interpreted by referring to the present ideas about stellar evolution. New arguments are put forward according to which the velocity distribution of stars younger than 5×10^9 years does not depend on stellar mass. The importance of the samples allows the testing of the information given by the evolutionary tracks about the origin of the giants by a kinematic method. The high-velocity stars seem to belong to two different populations according to their location in the HR diagram. (auth)

36311 COLLISION EXCITATION OF POSITIVE IONS IN p^q CONFIGURATIONS: TRANSITIONS BETWEEN LEVELS OF THE P TERM. PART II. Blaha, M. (National Bureau of Standards, Boulder, Colo. Univ. of Colorado, Boulder). Astron. Astrophys., 1: 42-3(Jan. 1969).

Electron collision cross sections for transitions between levels of the P term in the $2p^q$ and $3p^q$ (q = 1, 2, 3, 4, 5) configurations were calculated in a weak-coupling approximation with exchange. (auth)

36312 THE TWO-PHOTON TRANSITION PROBABILITIES FROM THE METASTABLE $2\ ^3S_1$ STATE IN THE HELIUM-LIKE SERIES. Bely, O.; Faucher, P. (Observatoire, Nice). Astron. Astrophys., 1: 37-41(Jan. 1969).

The recent theory developed by Drake and Dalgarno and by Bely for the two-photon transition probability from the metastable $2\ ^3S_1$ state in He I is applied to the isoelectronic sequence. It is shown that for all cases of interst ($Z \leq 30$) the transition probability varies as Z^{10} along the isoelectronic sequence. The calculations are carried out for He I, B IV, O VII, Mg XI, S XV, Sc XX, Fe XXV, and Ga XXX. The transition probabilities are given as well as the shape of the continuum generated by the simultaneous emission of the two photons. The shape of these continua shows a pronounced peak for a wavelength λ_m slightly longer than $\lambda(2\ ^3S_1 - 1\ ^1S_0)$. The λ_m's are tabulated. For $Z \geq 7$ an accuracy of about 10% is expected for the transition probabilities. (auth)

36313 CALCULATED PROFILES OF HeI 4471 AND 4922 A AND THEIR FORBIDDEN COMPONENTS. Barnard, A. J.; Cooper, J.; Shamey, L. J. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astron. Astrophys., 1: 28-36(Jan. 1969).

The profiles of He I 4471 and 4922 Å and their forbidden components were calculated and are tabulated for electron densities in the range 10^{14} to 10^{17} cm^{-3}, and for temperatures from 5000 to 40,000°K. The ion broadening is treated in the quasi-static approximation and the electron broadening of the overlapping Stark components in the impact approximation. Stark parameters are also tabulated from which profiles may be obtained for densities below 10^{14} cm^{-3}. (auth)

36314 CALCIUM ABUNDANCE IN 99 HERCULIS. Spite, M. (Observatoire de Paris, Meudon, France). Astron. Astrophys., 1: 52-3(Jan. 1969).

A model analysis of the metal-deficient star 99 Her shows that this star is Ca-rich, as are all the slightly metal-deficient FG stars studied in an earlier paper. (auth)

36315 THE STRUCTURE OF THE PLEIADES. Artyukhina, N. M. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 987-92(May-June 1969).

Translated from Astron. Zh., 45: 1246-53(Nov.-Dec. 1968).

From proper motions reported elsewhere, curves are derived for the apparent-density distribution of possible members of the Pleiades cluster brighter than 12.5m (identified by their proper motions) as a function of distance from the cluster center. The cluster is shown to comprise a nucleus of radius about 1° and a corona of radius 3.25°, in good accord with previous results. The cluster contains 184 stars brighter than 12.5m. The corona of the cluster includes 25% of the cluster members from 6.5 to 9.5m, and 50% of the members from 9.5 to 12.5m. (auth)

36316 SPECTROPHOTOMETRY OF THE SUPERNOVA REMNANTS IC 443 AND NGC 6888. Lozinskaya, T. A.; Esipov, V. F. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 913-18(May-June 1969).

Translated from Astron. Zh., 45: 1153-9(Nov.-Dec. 1968).

Spectra of individual regions in two filamentary nebulae, the supernova remnants IC 443 and NGC 6888, were obtained with a spectrograph equipped with an electronic image converter, mounted at the Cassegrain focus of the 125-cm reflector. Spectrograms at 25- and 50-Å/mm dispersion yielded relative intensities of the Hα and [N II] lines and values of the radial velocity and velocity dispersion for individual filaments. The expansion velocity of the two nebulae was estimated: about 90 km/sec for IC 443, and about 80 km/sec for NGC 6888. (auth)

36317 STARTING TIME OF A SUPERNOVA OUTBURST AND THE MASS OF THE EJECTED ENVELOPE. Pskovskii, Yu. P. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 919-23(May-June 1969).

Translated from Astron. Zh., 45: 1160-5(Nov.-Dec. 1968).

For type I and II supernovae the photographic amplitude of the rise in brightness is estimated to be 20m and 9 to 11m, respectively, and the rate of rise .20 and .13m per day. Hence, the duration of the rise is 100 days for type I and 70 to 80 days for type II. The energy released by typical supernovae in the photographic and visual spectral regions is computed. The appearance of for-

bidden neutral-oxygen lines in the spectrum of the supernova in IC 4182 on the 158th day after maximum light implies an electron concentration of 3×10^5 cm^{-3} and a mass of 0.1 to 0.4 solar masses for the supernova envelope. (auth)

36318 SIMILARITY SOLUTION FOR COLLAPSE THROUGH ENERGY LOSSES BY NEUTRINO RADIATION. Nadezhin, D. K. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 924-31 (May-June 1969).

Translated from Astron. Zh., 45: 1166-76 (Nov.-Dec. 1968).

Energy losses by neutrino radiation can lead to contraction of a star at a rate of the order of the sound velocity (collapse). An analysis is given of asymptotic similarity solutions for collapse, valid under conditions where the rate of energy loss by neutrino radiation and the equation of state can be approximated by power functions. A qualitative study is made of how the character of the solution depends on the values of the exponents and the adiabatic index. If the adiabatic index exceeds a certain critical value, then in addition to the simple similarity solution describing free fall with zero pressure, a free fall with a nonzero pressure constant in space can also exist, as well as nontrivial solutions. These last solutions have the property that when infinite density is attained at the center of the star, all the physical quantities remain finite outside the center. Such a solution is derived and is investigated for the case where the URCA process is the principal process of neutrino radiation. A calculation of the collapse preceding the explosion of a type II supernova, based on the appropriate partial differential equations, has demonstrated that the solutions do arrive at the similarity regime considered here. (auth)

36319 STRUCTURE OF STAR CLUSTERS AND THE MASS OF THE MEMBER STARS. Kholopov, P. N. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 978-86 (May-June 1969).

Translated from Astron. Zh., 45: 1235-45 (Nov.-Dec. 1968).

A comparison of the spatial density distributions f(r) of stars in different clusters provides evidence of a unified structure for all star clusters. The density distribution of the stars in any cluster may be characterized by two parameters: $D_r = |\log(r_0/R_c)|$, where r_0 is the radius of the central zone of the nucleus and R_c is the radius of the corona of the cluster; and $D_f = |\log[f(R_c)/f_0]|$, where f_0 is the central density of the system. The parameter D_r may serve as an indicator of the total mass of the cluster. The parameter D_f, specifying the range in density observed for a given stellar subsystem in a particular cluster, is a function of the average mass of the stars in the subsystem and of the age of the cluster. A relation is obtained between the mean mass of the stars and the range in density for the corresponding subsystems in star clusters of various ages. An effort to use this relation for estimating the masses of stars not conforming to the usual mass–luminosity law indicates that the masses of RR Lyrae stars could be as high as some 10 solar masses. The average mass of the red giants in different globular clusters may range from 1.5 to 10 solar masses. The more populous a cluster, the smaller the percentage of its faint members there will be in the nucleus of the system. The coronas of populous clusters contain up to 90% of the faint cluster members. The mass of the corona therefore comprises a substantial fraction of the total mass of a cluster and will definitely exceed the mass of the nucleus. (auth)

36320 INTERPRETATION OF THE LIGHT CURVES OF ECLIPSING SYSTEMS IF THE UNKNOWN FUNCTIONS ARE MONOTONIC. Cherepashchuk, A. M.; Goncharskii, A. V.; Yagola, A. G. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 944-55 (May-June 1969).

Translated from Astron. Zh., 45: 1191-1206 (Nov.-Dec. 1968).

A stable algorithm is described for finding a solution (and its uncertainty) among the class of monotonic bounded functions for the incorrectly formulated problem. The algorithm is applied to an interpretation of the light curve of YZ Cas in red light, for the classical model approximation of an eclipsing system. Values are obtained for the radii of the components, the orbital inclination, and the brightness distribution over the disks of the two components, with no significant a priori assumptions having been made about the physical properties of the components of the system. The error in the solution is estimated for certain fixed parameters. The solution obtained can describe the observed light curve of YZ Cas by a theoretical curve to within the observational accuracy. The limb darkening of the major component is found to differ to some extent from a "cosinusoidal" law. The estimates for the geometric parameters of the system and the brightness distribution over the disk of the minor component agree, to within the errors, with the corresponding elements obtained by Kron for YZ Cas. (auth)

36321 THEORETICAL VALUES OF LIMB-DARKENING COEFFICIENTS. Tabachnik, V. M. (Ushinskii Pedagogical Inst., Odessa). Sov. Astron. AJ (Engl. Transl.), 12: 956-61 (May-June 1969).

Translated from Astron. Zh., 45: 1207-14 (Nov.-Dec. 1968).

The problem of the effect of nonlinear limb darkening on the solution of light curves of eclipsing binary stars is discussed. The limb-darkening coefficients calculated from model light curves obtained on the basis of a nonlinear brightness distribution across the disk of the eclipsed component have a definite physical meaning, and the geometrical orbital elements practically coincide with the model values. It is shown that nonlinear limb darkening can be determined from observations of separated eclipsing binary systems of early spectral types, whose radius ratio, as well as the relative brightness of the eclipsed component, is close to unity. (auth)

36322 PHOTOELECTRIC OBSERVATIONS OF THE NUCLEI OF PLANETARY NEBULAE He 1-5 AND NGC 1514. Arkhipova, V. P. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 1036-8 (May-June 1969).

Translated from Astron. Zh., 45: 1312-15 (Nov.-Dec. 1968).

Photoelectric observations of the nuclei of the planetary nebulae He 1-5 and NGC 1514 carried out in October 1967, indicate that short-period brightness fluctuations (from 10 min to several hours) are absent, to within ±0.01m accuracy in the V and B systems and ±0.025m in the U system. The nucleus of He 1-5 probably experienced color variations between 1965 and 1967. (auth)

36323 ABSOLUTE SPECTROPHOTOMETRY OF SOME INFRARED LINES IN PLANETARY-NEBULA SPECTRA. Noskova, R. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 1039-40 (May-June 1969).

Translated from Astron. Zh., 45: 1315-18 (Nov.-Dec. 1968).

Absolute intensities [ergs · cm^{-2} · sec^{-1}] were determined for several infrared lines (8400–11,000 Å) in the spectra of the planetary nebulae BD + 30°3639, NGC 7662, NGC 40, IC 2149, and IC 4997. The observational material was obtained at the Crimean station of the Shternberg Astronomical Institute with a cesium oxide contact electronic image converter mounted at the Cassegrain focus of the 125-cm reflector. A0V stars were utilized for the absolute standardization. A comparison of the results obtained with other authors' data indicates satisfactory agreement. It has been demonstrated that absolute spectrophotometric work can be performed with acceptable accuracy by using contact image converters. (auth)

36324 ABSOLUTE DIMENSIONS OF 18 ECLIPSING BINARY SYSTEMS AND SOME EVOLUTIONARY CONSIDERATIONS. Popov, M. V. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 1033-5 (May-June 1969).

Translated from Astron. Zh., 45: 1309-11 (Nov.-Dec. 1968).

Absolute dimensions derived from published photometric and spectroscopic orbital elements are given for 18 interesting eclipsing binary systems. With these values a comparison is made between the parameters of the individual systems and the parameters that a close binary system might have at various stages in its evolution. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 36456.

36325 CONDITIONS FOR MICROWAVE RADIATION FROM EXCITED OH Λ-DOUBLET STATES. Litvak, M. M. (Massachusetts Inst. of Tech., Lexington); Zuckerman, B.; Dickinson, D. F. Astrophys. J., 156: 875-86 (June 1969).

The conditions are considered for observing Λ-doublet maser emission from an excited rotational level of OH according to the models of ultraviolet, infrared, and chemical pumping of anomalous ground-state OH 18-cm emission sources. The most intense emission and absorption lines, having frequencies near 6000 MHz, are expected to originate in the $^2\Pi_{\frac{3}{2}}$, $J = \frac{5}{2}$ state, maser emission being possible in the (F = 3 → 2)-transition due to trapping of far-infrared resonance-radiation alone. The (F = 1 → 0)-transition in the $^2\Pi_{\frac{3}{2}}$, $J = \frac{1}{2}$ state, and to a lesser extent the (F = 2 → 1)-transition in the $^2\Pi_{\frac{3}{2}}$, $J = \frac{3}{2}$ state, are also possible masers. (auth)

36326 DETERMINATIONS OF HELIUM ABUNDANCE FROM RADIOFREQUENCY RECOMBINATION LINES. Palmer, Patrick (Harvard Coll. Observatory, Cambridge, Mass.); Zuckerman, B.; Pentfield, H.; Lilley, A. E.; Mezger, P. G. Astrophys. J., 156: 887-901 (June 1969).

Radiofrequency recombination lines of helium were observed in five H II regions: Orion, M17, NGC 6357, IC 1795, and W51. The measurements were used to determine the ratios N_{He}/N_H in the nebulae, yielding an average value of 0.084 ± .003, which does not differ significantly from one nebula to another. The

optical determinations for H II regions were reexamined, and the radio value was compared with the optical ones and with values for early-type stars. Upper limits were obtained for the fraction of doubly ionized helium in M17 and Orion, and for the abundance of deuterium and ^{3}He in Orion. In NGC 2024, where no significant helium line was observed, an anomalous microwave recombination line was discovered. Anomalous lines are also suggested in the spectra of Orion, IC 1795, and W51. Their significance in determining helium abundances is discussed. (auth)

36327 THE GENERAL SOLUTION OF THE b_n PROBLEM FOR GASEOUS NEBULAE. Sejnowski, T. J. (Case Western Reserve Univ., Cleveland); Hjellming, Robert M. Astrophys. J., 156: 915-25(June 1969).

The departures of the populations of the excited states of hydrogen from those found under conditions of thermodynamic equilibrium are calculated using a general iterative method. Calculations of b_n and $d(\ln b_n)/dn$ are carried out for conditions found in gaseous nebulae, and the sensitivity of the solution to certain assumptions is discussed. (auth)

36328 RESULTS OF FIVE NIGHTS OF CONTINUOUS MONITORING OF THE OPTICAL FLUX FROM SCO X-1. Sandage, Allan; Westphal, J. A.; Kristian, Jerome (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 156: 927-42(June 1969).

Data obtained during five nights of continuous monitoring of the x-ray source Sco X-1 between April and June 1967 are shown in computer-generated point plots. (auth)

36329 INTERACTION OF X-RAY SOURCES WITH OPTICALLY THIN ENVIRONMENTS. Tarter, C. Bruce (Univ. of California, Livermore); Tucker, Wallace H.; Salpeter, Edwin E. Astrophys. J., 156: 943-51(June 1969).

The physical conditions in an optically thin gas surrounding a source of x rays are calculated for various combinations of parameters characterizing the source and the gas. The source of luminosity L is assumed to emit its radiation in the form of thermal bremsstrahlung at a temperature T_X, and the gas density N is assumed to be constant and low enough so that all ions, except those having metastable states, are in their ground states. The electron temperature and the ionization equilibrium of hydrogen, helium, carbon, nitrogen, oxygen, and neon are plotted as a function of the parameter L/Nr^2 (r is the distance from the source) for T_X equal to 1, 10, and 100 million degrees. The coefficient for absorption of x rays of various energies is calculated as a function of electron temperature for a gas excited by bremsstrahlung radiation, and for a gas whose equilibrium is established purely by collisions. The results are briefly applied to problems in x-ray astronomy. (auth)

36330 INTERACTION OF X-RAY SOURCES WITH OPTICALLY THICK ENVIRONMENTS. Tarter, C. Bruce (Univ. of California, Livermore); Salpeter, Edwin E. Astrophys. J., 156: 953-66(June 1969).

The physical conditions in a gas surrounding a source of x rays are calculated for situations in which the gas absorbs an appreciable fraction of the radiation emitted by the source. The source of luminosity L is assumed to emit its radiation in the form of thermal bremsstrahlung at temperature T_X, and the gas density N is assumed to be constant and low enough so that all ions, except those having metastable states, are in their ground states. The qualitative characteristics of the surrounding medium are discussed, and approximate scaling laws are derived in terms of certain characteristic lengths and their dimensionless ratios. The theory of radiative transfer is used to develop approximate methods for determining the radiation field in a spherical nebula in which continuous absorption, electron scattering, and diffuse ionizing radiation may all be important. For various combinations of the parameters L, T_X, and N, the electron temperature; the ionization equilibrium of hydrogen, helium, carbon, nitrogen, oxygen, and neon; and the visible, ultraviolet, and x-radiation fields are computed as a function of distance from the source. The results are discussed and briefly applied to cosmic x-ray sources and quasi-stellar sources. (auth)

36331 POLARIZATION OF DISCRETE SOURCES AT 21.2-CM WAVELENGTH, AND GALACTIC DEPOLARIZATION. Bologna, J. M.; McClain, E. F.; Sloanaker, R. M. (Naval Research Lab., Washington, D. C.). Astrophys. J., 156: 815-39(June 1969).

Results are given of measurements made at 21.2 cm with the NRAO 300-foot radio telescope of the linear polarizations and total flux densities of 156 sources having small angular diameters. The degrees of polarization of the 152 sources of the sample that are believed to be extragalactic are combined with the degrees of polarization of eighty-seven additional sources measured by other observers to study the depolarization of the radiation from extragalactic sources during its transit through our Galaxy. It is found that the depolarization is appreciable at 21 cm for sources in directions within about 120° of the galactic center in l(II) and up to 30° from the galactic plane in b(II). The data suggest that the magneto-ionic medium responsible for the depolarization extends into the galactic halo, although depolarization in a relatively thin disk cannot be ruled out. Inhomogeneities in the galactic magneto-ionic medium with a scale of 1 pc or less are required to explain the depolarization by differential Faraday rotation across the angular diameters of the sources. A lower limit of about 10^{-7} gauss cm^{-3} is required for the small-scale component of the product of electron density and magnetic-field strength. Analysis of data from other observers shows no evidence of appreciable galactic depolarization at wavelengths of about 11 cm. No obvious correlations are found between degree of polarization at 21 cm and various intrinsic source properties. (auth)

36332 THE SPECTRA OF DISCRETE RADIO SOURCES AT DECAMETRIC WAVELENGTHS. I. Braude, S. Ya.; Lebedeva, O. M.; Megn, A. V.; Ryabov, B. P.; Zhouck, I. N. (Inst. of Radiophysics and Electronics, Kharkov). Mon. Notic. Roy. Astron. Soc., 143: 289-300(1969).

A description is given of the methods used and the results of measurements made on 80 discrete radio source spectra in the decametric wavelength range. Flux densities are given for frequencies 12.6, 14.7, 16.7, 20 and 25 MHz. (auth) (UK)

36333 PULSARS AS NONRADIAL OSCILLATORS. Baglin, A.; Heyvaerts, J. (Inst. of Astrophysics, Paris). Nature (London), 222: 1258-60(June 28, 1969).

The theme of this communication is that the periodicity of pulsars may be attributed to a nonradial gravity wave in the almost adiabatic matter of degenerate neutron stars. Because high modes are difficult to excite it is assumed that the vibration is the first gravity mode of the second spherical harmonic. A very simple stellar configuration is employed, in which the density is everywhere small enough to neglect repulsive potentials and hyperon formation in the first approximation. The gravitational radius is small compared with the actual radius of the star, so that order of magnitude values are still obtained for the frequencies in the Newtonian approximation. The radiation mechanism could be due to some kind of shock wave; the radio emission might be explained on the basis of coherent bremsstrahlung from a collisionless shock wave, but in some cases the optical pulses are difficult to explain. The period of the oscillation is sensitive only to the internal temperature, so that observed increases in period must be interpreted as a cooling of the star. The discovery of pulsars in supernovae sites supports the notion that they were formed during supernovae explosions; the outer layers of the exploding star are ejected, but the central regions shrink violently into a very dense configuration leading to an oscillation in the dense core, which it is proposed is responsible for the pulsating signals. If the damping time scale is shorter than the pulsar lifetime a driving mechanism is necessary; energy storage in the large magnetic field appears to be of the right order of magnitude to feed the oscillation. The problem of damping by gravitational radiation is discussed, but no general solutions have been found. The model discussed was chosen so that neutrino production is unimportant, and damping due to neutrino emission during the oscillation is also negligible. Radiative damping in the outer nondegenerate layers is examined. The model is also able to explain the period range of pulsars. (UK)

36334 DECREASE IN THE PERIOD OF PULSAR PSR 0833-45. Durney, B. (High Altitude Observatory, Boulder, Colo.). Nature (London), 222: 1260-1(June 28, 1969).

A decrease of 196 ns in the period of this pulsar was observed, and it is suggested that this decrease is due to the addition of mass to the pulsar. A remnant of the supernova explosion which formed the pulsar may not have escaped the gravitational field and may have fallen back on the pulsar. This possibility is treated mathematically, and tabulated values are given for increase in mass necessary to account for the decrease in period as a function of central density, involving the radiating dipole hypothesis. (UK)

36335 SOME DIFFICULTIES WITH THE OBLIQUE ROTATOR MODEL FOR PULSARS. Papagiannis, M. D. (Boston Univ.). Nature (London), 222: 1261-2(June 28, 1969).

Most of the available evidence concerning pulsars suggests that they are produced by rapidly rotating neutron stars. Reference is made to the model proposed by Gold (Nature 218: 731 (1968)); it is thought that this may be an oversimplification of the problem. The oblique rotator model seems to be more appropriate, involving rapidly spinning neutron stars with a dipole field, the axis of which is at an angle to the rotational axis of the

star. Some basic difficulties associated with this model are discussed. (UK)

36336 AVERAGE PULSAR ENERGIES AT CENTIMETRE WAVELENGTHS. Downs, G. S.; Morris, G. A.; Reichley, P. E. (California Inst. of Tech., Pasadena). Nature (London), 222: 1257-8(June 28, 1969).

Studies made in Oct. 1968 are described on the seven pulsars CP 0328, PSR 0833, CP 0950, CP 1133, JP 1933, AP 2015, and PSR 2045 at 12.5 cm. (2,388 MHz) wavelength, using an 85-foot azimuth–elevation antenna at the Goldstone Tracking Station, California. CP 0950, CP 1133, and AP 2015 were also studied at 3.5 cm (8,448 MHz). The data were analysed to determine the activity level of each pulsar averaged over several weeks, and average pulse energies are tabulated for the 12.5-cm observations, together with upper limits for the 3.5-cm observations. The observations indicated source spectra with high-frequency cutoffs. Results for each pulsar are discussed. (UK)

36337 THE SPECTRA OF DISCRETE RADIO SOURCES AT DECAMETRIC WAVELENGTHS. II. Braude, S. Ya.; Lebedeva, O. M.; Megn, A. V.; Ryabov, B. P.; Zhouck, I. N. (Inst. of Radiophysics and Electronics, Kharkov). Mon. Notic. Roy. Astron. Soc., 143: 301-17(1969).

The spectra of discrete radio sources measured in the wavelength range of 12.6 to 25 MHz are analysed and classified. Besides the well-known spectral types with zero and negative curvature, the spectra include a type with positive curvature and also some with a complicated shape exhibiting curvature of variable sign. Preliminary results of measurements of the stability of the spectral characteristics show that most sources have spectra which are relatively stable with time, but that the sources 3C 84, 3C 144, and 3C 461 show variable spectra with a variation increasing at decreasing frequency in the decametric range. Some mechanisms of the radio-wave generation leading to various spectral types are discussed. (auth) (UK)

36338 MEASUREMENT OF THE SPECTRUM OF 387 RADIO SOURCES AT CENTIMETRE WAVELENGTHS. I. Horton, P. W.; Conway, R. G.; Daintree, E. J. (Univ. of Manchester, Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc., 143: 245-71(1969).

The flux densities of 387 radio sources, predominantly from the 3C and 3CR catalogues, were measured at 2695 MHz using the Jodrell Bank Mark II telescope. Further measurements of the flux density at 4995 MHz were made for 188 of these sources. The observations were combined with other published data to provide the continuum spectra of the 387 sources within the frequency range 178 to 8000 MHz. The tentative result of Conway, Kellermann & Long (1963), that the spectra of some sources steepen above 1400 MHz, was confirmed for 38% of these sources. In general, the accuracy of the data was only consistent with the fitting of one overall simple power-law spectrum, or two successive power-law spectra in the case of sources whose spectra were found to steepen at the higher frequencies. (auth) (UK)

36339 INTERGALACTIC H I EMISSION AT 21 CENTIMETERS. Penzias, A. A.; Wilson, R. W. (Bell Telephone Labs., Inc., Holmdel, N. J.). Astrophys. J., 156: 799-802(June 1969).

A search for a "step" in sky brightness temperature around 21 cm was made with negative results. The limit obtained, 0.00 ± 0.08°K, suggests a maximum density of 5×10^{-30} g cm^{-3} for intergalactic H I. (auth)

36340 LOW-DENSITY ASTROPHYSICS: H^+ REGIONS AND THE SOLAR CORONA. Seaton, M. J. (University Coll., London). pp 501-8 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Selected topics in the astrophysics of H^+ regions and of the solar corona, which may be of interest to atomic physicists, are reviewed. Methods of determination of electron temperatures in H^+ regions, oxygen-ion abundances in H^+ regions, and the ionization equilibrium in the solar corona are discussed. (A.G.W.)

36341 LOW-DENSITY ASTROPHYSICS: H I REGIONS. Field, George B. (Univ. of California, Berkeley). pp 487-99 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Two areas in which atomic physics is important in study of H I regions are reviewed: the determination of the chemical composition of the gas, and the processes by which the gas radiates. The possibilities for formation and excitation of interstellar molecules such as H_2, CH, and OH and the abundances of minor constituents are considered. Conditions for formation of shock waves in interstellar H I regions and conditions existing behind the shock front are discussed. Problems needing further investigation are pointed out briefly. 38 references. (A.G.W.)

36342 A REMNANT OF A LARGE-SCALE EXPLOSIVE EVENT IN THE GALACTIC PLANE AROUND LONGITUDE 60°. Katgert, P. (Sterrewacht, Leiden). Astron. Astrophys., 1: 54-61(Jan. 1969).

From observations of the 21-cm line of neutral hydrogen it appears that a peculiar object exists in the galactic plane around longitude 60°. The object is remarkable in that its radial velocity exceeds the maximum velocity corresponding to the adopted rotation curve by about 7 km/s. The internal velocity dispersion in the object is about 3.5 km/s (in one coordinate) and the mean surface density is 2.6×10^{20} H atoms/cm^2. The ring-like structure (diameter ≈4°) suggests that the object originated from an explosive event. (auth)

36343 OBSERVATION OF FIVE SOURCES OF COSMIC X RAYS IN THE 15 TO 150-keV ENERGY RANGE. Rocchia, R.; Rothenflug, R.; Boclet, D.; Durouchoux, Ph (CEN, Saclay, France). Astron. Astrophys., 1: 48-51(Jan. 1969).

Among the cosmic x-ray sources discovered by U. S. rockets, five of them that happened to pass close to zenith in France were chosen for analysis of their spectra in the 15- to 130-keV energy range. In 1967, three balloon flights were made for long-time observation of four sources in Cygnus and of the Crab Nebula. Due to the extension of the energy range, a difference can be seen between thermal bremsstrahlung ($dN/dE \sim E^{-1} \exp - E/kT$) and the other processes: $dN/dE \sim E^{-n}$ probably generated by synchrotron radiation or by the inverse Compton effect. According to the results, only the source Cygnus X 2 has a spectrum compatible with a thermal spectrum. On the other hand the intensity of Taurus X 1 seems unsteady. These two main aspects of the experiment are discussed, and results on Cyg X 1, Cyg X 3, and Cyg X 4 are compared with results published recently. (auth)

36344 COSMIC RADIO NOISE INTENSITY FRO M 0.45 TO 3.0 MHz OBSERVED BY THE ATS II SATELLITE. Weber, Richard R.; Stone, Robert G.; Somerlock, C. Raymond (Goddard Space Flight Center, Greenbelt, Md.). Astron. Astrophys., 1: 44-7(Jan. 1969).

The ATS II satellite, launched on April 6, 1967, carried a Ryle–Vonberg radiometer and a 76 meter wide angle V antenna. Radio noise measurements were obtained from 0.45 to 3.0 MHz for an altitude range of 180 to 11,000 km. The existence of some spacecraft radio interference allows establishment only of upper limits to the continuum spectrum, which shows a substantial decrease at the lower frequencies. Using this data and other low frequency observations in a two-component galactic model, an emission measure of 1.2 cm^{-6} pc towards the galactic poles is computed. (auth)

36345 HIGH ENERGY X-RAY STUDY OF M-87. McClintock, J. E.; Lewin, W. H. G.; Sullivan, R. J.; Clark, G. W. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 223: 162-3(July 12, 1969).

A search was made for x rays from M-87 using a balloon-borne detector comprising two xenon proportional counter arrays with a combined sensitive area of 2,000 cm^2. A five-channel pulse-height analyzer in each system covered the energy range 15 to 65 keV. Upper limits on the energy flux from M-87 are tabulated and x-ray measurements are shown in graphical form. (UK)

36346 WATER VAPOR: OBSERVATIONS OF GALACTIC SOURCES. Meeks, M. L. (Massachusetts Inst. of Tech., Lexington); Carter, J. C.; Barrett, A. H.; Schwartz, P. R.; Waters, J. W.; Brown III, W. E. Science, 165: 180-4(July 11, 1969).

The emission of water vapor was measured at a wavelength of 1.35 centimeters from nine sources with the 120-foot (36.5-meter) Haystack antenna. Eight sources lie within 30 seconds of arc of the hydroxyl sources of 18 centimeters but not all hydroxyl sources produced detectable emission of water vapor. All sources are smaller than 30 seconds of arc in angular diameter, but at least three separate sources were resolved in the Orion Nebula. It was not found that the known hyperfine components are present with the equilibrium intensity distribution. (auth)

36347 VARIABILITY OF FLUX DENSITIES OF SOME RADIO SOURCES AT THE FREQUENCY OF 5760 MHz. Kostenko, V. I.; Matveenko, L. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 936-8(May-June 1969).

Translated from Astron. Zh., 45: 1181-4(Nov.-Dec. 1968).

Results of measurements of flux densities of variable radio sources 3C 84, 3C 273, 3C 279, and 3C 345 at a frequency of 5760 MHz during February 1966–May 1967 are presented. The depen-

dences characterizing the variability of these radio sources during the period under consideration are studied. The age of the variable components of the radio sources is estimated assuming a synchrotron mechanism of radiation. (auth)

36348 NEUTRINO LUMINOSITY OF SUPERDENSE STARS. Shishkin, G. V. Dokl. Akad. Nauk BSSR, 13: 227-30(Mar. 1969). (In Russian).

The premise, that the Fermi gas of elementary particles of Ambartsumyan and Saakyan (Astron. Zh., 37: 193(1960) and 38: 1016(1961)) is not completely degenerate, allows proof that such configurations can, by means of neutrino radiation, emit energies of the order of magnitude of quasars. (tr-auth)

36349 RADIO LINES OF THE INTERSTELLAR NO MOLECULE. Kotsev, I. N.; Georgiev, G. I.; Kontorovich, V. M. (Gorky Univ., Kharkov). Sov. Astron. AJ (Engl. Transl.), 12: 1030-2(May-June 1969).

Translated from Astron. Zh., 45: 1306-8(Nov.-Dec. 1968).

The possibilities for observing radio lines of the interstellar NO molecule are discussed. The frequencies of the transitions between the hyperfine Λ-doubling components of the rotational levels are computed, and the optical thickness is estimated for lines in the decameter, centimeter, and millimeter wavelength ranges. Detection of the 2-mm lines would apparently be possible if the sensitivity of present equipment could be increased by an order of magnitude. (auth)

Solar Phenomena

Refer also to abstracts 36541, 36542, and 36549.

36350 (AD-685230) SOLAR RESEARCH AND DEVELOPMENT AT SACRAMENTO PEAK OBSERVATORY. Final Report, January 1, 1967-December 31, 1968. Jones, Mark W. (Geo-Science Research, Inc., Alamogordo, N. Mex.). Jan. 1969. Contract F19628-67-C-0199. 16p. (AFCRL-69-51). CFSTI.

The fundamental research work included spectral studies of solar flares, prominences, and plages with the Universal Spectrograph, and analyses of the data from the 1965 and 1966 solar eclipse expeditions. The electronics group contributed to the overall instrumentation design and development programs; these involved automation systems for the collection and reduction of solar data, control systems for the spectrographic instruments, the solar flare patrol system, the video systems, and the instrumentation systems for the solar tower. (auth) (USGRDR)

36351 LONG-WAVELENGTH TURBULENCE AND THE HEATING OF THE SOLAR WIND. Jokipii, J. R. (Univ. of Chicago); Davis, Leverett Jr. Astrophys. J., 156: 1101-6(June 1969).

A model of the solar wind is proposed in which the observed long-lived velocity streams are the source of long-wavelength turbulence, which in turn serves as an efficient and variable heat source for the solar plasma. The turbulence is characterized by the lack of an equilibrium subrange of wavenumbers, owing to the rapid damping of the waves by direct interaction with the thermal plasma. The model suggests that α particles are heated more than protons ($T_\alpha \sim 4T_p$) and predicts an effective end to turbulence and heating at a heliocentric radius of some 5 to 10 AU. Both predictions agree with observations. (auth)

36352 INTERPLANETARY GAS. XVI. A CALCULATION OF THE ANGULAR MOMENTUM OF THE SOLAR WIND. Brandt, John C. (Goddard Space Flight Center, Greenbelt, Md.); Wolff, Charles; Cassinelli, Joseph P. Astrophys. J., 156: 1117-24 (June 1969).

A model of the quiet solar wind with magnetic field was calculated numerically using the momentum equations developed by Weber and Davis, but with energy transport governed by the first law of thermodynamics with heat conduction. The model is close to observed densities of coronal electrons for $r \gtrsim 2\ R_\odot$. Near the Earth, the model has $N_e = 6\ cm^{-3}$, $w = 315\ km\ sec^{-1}$, $T = 325000°K$, and a garden-hose angle of 55°; the Alfvén point is at $r = 31.4\ R_\odot$, and the angular momentum per unit mass in the solar equator is $L = 1.4 \times 10^{19}\ cm^2\ sec^{-1}$, a value which gives an e-folding time for solar rotational braking of 5×10^9 yr. The azimuthal velocity (w_ϕ) of the plasma near Earth is 2.5 km sec^{-1}, and this value is consistent with the determination for quiet times from Type I comet tails. (auth)

36353 THE SOLAR [Fe II] LINES. Withbroe, George L. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 156: 1177-9(June 1969).

Theoretical equivalent widths for solar [Fe II] lines calculated with five photospheric models are compared with observed values. (auth)

36354 SOLAR ENERGY WITHOUT NEUTRINOS: FUSION CATALYSIS BY QUARKS. Libby, L. Marshall (Univ. of Colorado, Boulder. Rand Corp., Santa Monica, Calif.). Nature (London), 222: 1238-40(June 28, 1969).

It is postulated that negatively charged quarks and antiquarks may catalyse fusion in light elements. The solar energy output could be provided by quark catalysis of the alpha fusion reaction without production of neutrinos. The required abundance of quarks is $\sim 10^{-33}$ per proton if there are no heavy elements inside the Sun and is $\sim 10^{-14}$ per proton if heavy element occurrence is like that in the solar system (10^{-6}). In the latter case, the reaction rate is strongly temperature-dependent. (auth) (UK)

36355 ANISOTROPY OF THE SOLAR WIND. Griffel, D. H. (Univ. of Bristol, Eng.); Davis, L. Planet. Space Sci., 17: 1009-20(May 1969).

Beyond about 0.1 AU the density of the solar wind is so low that Coulomb collisions cannot keep the velocity distribution isotropic and Maxwellian. Analysis of the particle dynamics in an ideal spiral interplanetary magnetic field indicates that if there are no collisions beyond 0.1 AU, then at the Earth the temperature of the wind is very anisotropic, with $T_\parallel/T_\perp = 35$; this value is much greater than is observed. To study the effects of interactions with magnetic irregularities Boltzmann's equation was solved numerically with Krook's collision term; this shows that the anisotropy observed by the Vela satellite requires each particle to make an average of 2 or 3 collisions between 0.1 and 1 AU. The temperature averaged over direction roughly follows an adiabatic law, with $\gamma = 3/2$; γ tends to increase with distance. The theory predicts an excess of high-velocity particles, as observed by Vela, even when the collision frequency is independent of velocity, but to produce an effect as strong as that observed requires a fairly strong velocity dependence of the collision frequency. (auth) (UK)

36356 SPECTROSCOPIC ANALYSIS OF FAINT PROMINENCES. Stellmacher, G. (Institut d'Astrophysique, Paris). Astron. Astrophys., 1: 62-8(Jan. 1969). (In French).

The following results were obtained from a spectroscopic analysis of faint prominences: kinetic temperature from linewidths: 6000 to 7000°K; turbulent velocity $\xi_{tu} = 5\ km\ s^{-1}$; electron density $\eta_e = 3 \cdot 10^{10}\ cm^{-3}$. For all observed prominences a common state of excitation was found with considerable departures from L.T.E. For the H atom, these departures are characterized by $b_{0,2} = 40$, $b_{0,3} = 2$, $b_{0,k} = 1$ ($k \geq 4$). The higher levels of the H atom and He atom are found to be in equilibrium with the free electrons at a temperature $T_e = 6000$ to 6250°K. The Balmer decrement gave $E_\alpha/E_\beta = 12$ (after correction for self-absorption). For the $3\ ^3D$ level of He is found $b_{0,3}{}^3D = 1.25$. The populations of the $3\ ^3D$ level and the third level (0,3) of the H atom are influenced by resonance scattering of the visible photospheric radiation. (auth)

36357 MAGNETIC FIELDS IN THE CONVECTION CELLS OF THE SUPERGRANULATION ZONE. Getling, A. V. (Moscow Univ.). Sov. Astron. AJ (Engl. Transl.), 12: 967-72(May-June 1969).

Translated from Astron. Zh., 45: 1222-8(Nov.-Dec. 1968).

The equation of electromagnetic induction is solved for a model convection cell in a perfectly conducting medium. The resulting expressions enable one to calculate an initially homogeneous magnetic field in the cell as a function of the coordinates and time, depending on the choice of parameters and the velocity distribution. As an illustration such calculations are performed for one possible pattern of motion using empirical data on solar supergranules. If there is a weak horizontal field it can be substantially strengthened in the central part of the cell after a period of the order of a day and could give rise to a bipolar sunspot group. If the initial field is stronger a bipolar magnetic region or group of sunspots could appear at the interface between adjacent supergranules. In the case of a vertical initial field the crowding of lines of force anticipated by Pikel'ner would arise at the periphery of the cell. (auth)

36358 EVOLUTION OF HIGH-TEMPERATURE REGIONS UNDER COSMIC CONDITIONS. Korchak, A. A.; Platov, Yu. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 939-43(May-June 1969).

Translated from Astron. Zh., 45: 1185-90(Nov.-Dec. 1968).

The problem of the cooling of an isolated region initially heated to a very high temperature $T \approx 10^{8}$°K is considered. Losses by heat conduction, bremsstrahlung, and line and recombination radiation are taken into account. From the characteristic curve for the variation of the temperature with time one can estimate the mean gas concentration, the volume of the high-temperature region, and the power of the heat source. The results of the calculation are illustrated with two solar flares as examples. (auth)

36359 THE ROLE OF ELECTRON COLLISION IN THE DISSOCIATION OF CO MOLECULES ON THE SUN. Sarychev, A. P.; Sitnik, G. F. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 1027-9 (May-June 1969).

Translated from Astron. Zh., 45: 1303-5 (Nov.-Dec. 1968).

The dissociation rate of CO by electron collision in the upper layers of the solar photosphere is estimated from experimental results on the collision of electrons with molecules. A comparison of this rate with rates previously computed for photodissociation and dissociation through collision with hydrogen atoms indicates that electron collision will make no appreciable contribution to the decay of CO molecules on the Sun. (auth)

36360 STRUCTURE AND DEVELOPMENT OF SOLAR ACTIVE REGIONS. Symposium No. 35 Held In Budapest, Hungary, 4–8 September 1967. Kiepenheuer, K. O. (ed.). International Astronomical Union Symposium No. 35. New York, Springer-Verlag New York Inc., 1968. 623p. $30.00. (In English and French). (CONF-670953).

The symposium was dedicated to the study of active regions of the Sun, comprising all the well-known phenomena such as spots, faculae, flares, prominences, etc. Separate abstracts were prepared for 80 of the 89 papers presented. (W.D.M.)

For abstracts of individual papers see: 36361–36440.

36361 PATTERNS OF ACTIVE REGION MAGNETIC FIELD DEVELOPMENT. Bumba, V. (Astronomical Inst., Ondrejov, Czech.); Howard, R.; Martres, M. J.; Soru-Iscovici, I. Int. Astron. Union Symp., No. 35, 13-24 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Some characteristics of the appearance and development of magnetic fields within active regions as well as the large-scale ordering of activity into complexes of activity are discussed. It is not possible to separate a study of the evolution of active regions from a study of the model of the activity cycle. Many of the results obtained in the last few years concerning the development of active regions and large-scale activity have not been easily explained within any of the solar activity models. A chronological scheme of the development of a "typical" C- or D-type active region is presented. It is pointed out that the appearance of magnetic flux at the solar surface seems always to be a relatively rapid event, occurring during the course of a day or so. If the region does not receive more magnetic flux to make it a large region or if there is not a resurgence of activity later in its lifetime, the rest of the development is a gradual expansion and mixing of magnetic flux with the surrounding background field pattern. (auth)

36362 ORIGIN OF SOLAR ACTIVE REGIONS "ANOMALIES". Martres, M. J. (Observatoire, Meudon, France). Int. Astron. Union Symp., No. 35, 25-32 (1968). (In French).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Solar active regions are considered "anomalous" when they belong to magnetic classes γ, $\beta\gamma$, and $\beta f - \alpha f$. The study of the solar activity of the region where, later on, these groups are born shows an evident correlation between the presence of an old active center and the complexity of the new active region. It is found that the complexity is greater if the old active center is younger, and the superposition better. It is also observed that the birth of anomalous sunspot groups occur much more frequently on the western side of the magnetic inversion line of the old center. When the birth of an active center occurs outside and on the west of the faculae, the weakly anomalous groups $\beta f - \alpha f$ are observed. The "perturbation" decreases with distance and is extended at least to 10 heliographic degrees of the boundaries of the old faculae. (auth)

36363 MAGNETIC CLASSIFICATION OF ACTIVE REGIONS. Smith, Sara F. (Lockheed Solar Observatory, Burbank, Calif.); Howard, Robert. Int. Astron. Union Symp., No. 35, 33-42 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

All the active regions observed on the Sun with the Mount Wilson magnetograph between August 1959 and December 1962 have been given magnetic classifications in a system similar to the Mount Wilson sunspot-classification scheme. The flare productivity of regions classified as unipolar, bipolar, and complex bipolar, as well as regions composed of multiple bipolar components has been studied. It has not been necessary to provide a classification corresponding to the γ class of sunspots. Although the relatively poor angular resolution employed in the magnetograms limits somewhat the accuracy of the data, it is clear that both complex bipolar regions and regions with multiple bipolar components produce more than three times the number of flares than the simple bipolar regions produce. The most flare-productive class of regions is the reversed polarity complex classification. The statistical relation of the spot magnetic-field classification to the classification of the corresponding plage fields has been studied and found to be poor for these data. The distribution of the magnetic regions in latitude shows that many of the regions with polarities reversed from the usual orientation are confined to the equatorial zone. (auth)

36364 DEVELOPMENT OF MAGNETIC FIELDS IN ACTIVE REGIONS. Tandberg-Hanssen, E.; Porter, C. (High Altitude Observatory, Boulder, Colo.). Int. Astron. Union Symp., No. 35, 43-6 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The magnetograph of the High Altitude Observatory station at Climax was used to study changes in the longitudinal component of the magnetic field in a number of active regions. By securing simultaneous Hα pictures of the regions the magnetic data are compared with the optical appearance of the plages. From such studies the results of two active regions are presented. (auth)

36365 THE BALANCE OF MAGNETIC FLUXES IN ACTIVE REGIONS. Stenflo, Jan Olof (Astronomical Observatory, Lund, Sweden). Int. Astron. Union Symp., No. 35, 47-9 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A study was made on the balance of magnetic fluxes in active regions and its variation with field strength. Isogauss maps of sunspot groups recorded in 1963 and 1965 with the magnetograph at the Crimean Astrophysical Observatory were used for the study of the flux balance. (W.D.M.)

36366 SOME PATTERNS IN THE DEVELOPMENT OF CENTERS OF SOLAR ACTIVITY, 1962–66. Dodson, Helen W.; Hedeman, E. Ruth (Univ. of Michigan, Pontiac). Int. Astron. Union Symp., No. 35, 56-63 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A graphical representation of the 66 solar rotations (Carrington) between January 1, 1962 and December 31, 1966 has been prepared. It includes all centers of activity for which the calcium plage attained an area of at least 1000 millionths of the solar hemisphere and/or intensity 3 (McMath scale). In this study the antecedents, descendents, and neighbors of each region can easily be discerned. The work shows clearly that zones of activity, apparently closely related and much larger than single plages existed for long intervals of time. For example, the significant increases in solar activity in February, May, and October of 1965 occurred in a "family" of calcium plages apparently related through similarities of position and strong radio emission. The members of "families" of centers of activity are found at systematically changing longitudes. For some "families" the change of longitude appears to be primarily a consequence of differential rotation; for others, the pattern of formation of active centers dominates. According to the data for 1962–66 a meaningful study of the development of a center of activity may require consideration not only of the past history of the zone of the Sun in which it occurs but also of the zone approximately 180° away on the opposite hemisphere. (auth)

36367 LAST PHASES OF DEVELOPMENT OF ACTIVE REGIONS. Bumba, V. (Astronomical Inst., Ondrejov, Czech.); Kleczek, J.; Olmr, J.; Ruzickova-Topolova, B.; Sykora, J. Int. Astron. Union Symp., No. 35, 64-7 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A close relation of filament feet to the supergranular structure was found. Green corona brightness, 1420-MHz flux, and the location of quiescent filaments depend upon the distribution of the photospheric magnetic fields. The development of polar maxima of the green corona and their relation to the following polarity have been studied. (auth)

36368 SOME PROPERTIES OF THE VELOCITY FIELD IN A DEVELOPED ACTIVE REGION. Gopasyuk, S. I. (Crimean Astrophysical Observatory, Nauchny, USSR). Int. Astron. Union Symp., No. 35, 68-9 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Thirty-eight series of photoelectric recordings of radial velocities in a developed active region were studied. The recordings were made in the Fe I line 5250 Å from Sept. 2–7, 1961, when the active region passed across the solar disk from E 30° to W 42°. (W.D.M.)

36369 MIGRATION OF SUNSPOT ACTIVITY ALONG SOLAR MERIDIANS AND PARALLELS. Dezsoe, L.; Gerlei, O.; Kovacs, Agnes (Heliophysical Observatory, Debrecen, Hungary). Int. Astron. Union Symp., No. 35, 70-6 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The places of local maxima of sunspot activity, i.e., the formation of solar-active regions, seem to follow in a definite sequence of tracks over the Sun's surface. These sequences of activity apparently represent distinct continuous streams, whose duration may be of the order of magnitude of 1 year. (auth)

36370 CHROMOSPHERIC EXPLOSIONS AND SATELLITE SUNSPOTS. Rust, David M. (California Inst. of Tech., Pasadena). Int. Astron. Union Symp., No. 35, 77-84 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Observations of the longitudinal component of the photospheric magnetic fields near sunspots imply that surges and Ellerman bombs occur at neutral points in the magnetic fields (i.e., $|B| = 0$) in the chromosphere. The neutral points appear above satellite sunspots, which are defined as polarity reversals (in $B_{||}$) near the edges of large-spot penumbrae. A series of magnetograph observations shows a point of satellite polarity vanishing during a period of almost continuous surge activity. The lost magnetic energy is comparable to the energy release evidenced by the surge. (auth)

36371 STUDY OF AN ACTIVE REGION OF THE SUN DURING THREE ROTATION PERIODS. Macris, Constantin J.; Prokakis, T. J. (Astronomical Inst., Athens). Int. Astron. Union Symp., No. 35, 85-91 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The abnormal evolution of an active region during three solar rotations is studied. The high density of flares during the second and third rotation seems to be caused by the collision of new active centers with existing ones. The increase of the activity is probably due to the disturbance of the magnetic field, which became more complex because of the appearance of new centers near the original one. (auth)

36372 MAGNETOHYDRODYNAMICS OF AN ACTIVE REGION. Schmidt, H. U. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Int. Astron. Union Symp., No. 35, 95-107 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The dynamics of the magnetic fields embedded into the non-stationary outer layers of the Sun show many facets of interest, a few of which are reviewed in this article. The electric conductivity in these layers is high enough to keep matter and magnetic flux together for rather long times, so that one can discuss the most important questions within the framework of MHD with infinite conductivity. The discussion is concentrated mainly on the layers below the photosphere, where the matter controls the motion of the field, the intermediate state near the photosphere, where matter and field have comparable energy, and the upper layers where the field controls the material motion. (W.D.M.)

36373 CONCENTRATION OF MAGNETIC FIELDS IN THE DEEP CONVECTION ZONE. Simon, G. W. (Sacramento Peak Observatory, Sunspot, N. Mex.); Weiss, N. O. Int. Astron. Union Symp., No. 35, 108-11 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The strong magnetic fields observed between supergranules indicate that there must be subphotospheric convection in cells with a preferred diameter of about 30,000 km. Orthodox mixing length theory assumes that the dimensions of cells are limited by the density scale height. This is adequate for explaining granules but cannot account for supergranulation. A model is therefore proposed in which cellular motions extend over several scale heights. In addition to granules and supergranules, this model predicts a third characteristic scale of motion, with giant cells around 300,000 km in diameter. These cells may produce a pattern of magnetic fields like that suggested by Bumba and Howard for complexes of activity. (auth)

36374 OSCILLATORY MODES OF ENERGY TRANSPORT IN SOLAR MAGNETIC REGIONS. Danielson, R. E.; Savage, B. D. (Princeton Univ., N. J.). Int. Astron. Union Symp., No. 35, 112-25 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

It appears that it is necessary to look for oscillatory (i.e., overstable) instabilities as the cause of energy transport in sunspots. Making use of recent calculations on the hydromagnetic stability of thermally unstable layers with open boundary conditions, it is found that oscillatory modes can occur in the interior of sunspots. Some possible consequences of these oscillatory modes are discussed. (auth)

36375 OSCILLATORY CONVECTION IN STRONG MAGNETIC FIELDS AND ORIGIN OF ACTIVE REGIONS. Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow); Zhugzhda, Y. D. Int. Astron. Union Symp., No. 35, 127-30 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The convection in a compressible inhomogeneous conducting fluid in the presence of a vertical uniform magnetic field was studied. It is shown that a new mode of oscillatory convection occurs, which exists in arbitrarily strong magnetic fields. The convective cells are stretched along the magnetic field, their horizontal dimensions are determined by radiative cooling. Criteria for convective instability in a polytropic atmosphere are obtained for various boundary conditions in the case when the Alfvén velocity is higher compared with the velocity of sound. The role of oscillatory convection in the origin of sunspots and active regions is discussed. (auth)

36376 QUANTITATIVE ESTIMATIONS OF THE ANOMALOUS PLASMA DIFFUSION IN AN ACTIVE REGION. Kopecky, M.; Kuklin, G. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Propagation, Irkutsk, USSR). Int. Astron. Union Symp., No. 35, 131-3 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Recently, the interdependence of the gas and magnetic-field motions in the solar atmosphere has been considered. Some results indicate the occurrence of gas motion along the field lines combined with motion of the field line, but sometimes one has to assume an obvious gas motion across the field lines. As one of the possible mechanisms explaining this fact the anomalous plasma diffusion may be proposed. An attempt is made to estimate the Böhm-diffusion effect. (W.D.M.)

36377 CRITICAL STUDY OF A CURRENT-FREE FIELD IN THE SOLAR ATMOSPHERE. Rayrole, J.; Semel, M. (Observatoire, Meudon, France). Int. Astron. Union Symp., No. 35, 134-41 (1968). (In French).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

To test the validity of the assumption of a "current-free" magnetic field in the atmosphere above sunspots, all three parameters of the magnetic field in an active region were measured and compared with the calculated current-free field according to the solution proposed by Schmidt. Important differences were found between the calculated and the measured field. An earlier paper is referenced where the objections to the "current-free field" were that the calculated field has too simple a configuration to account for the fine structure observed in Hα and other solar observations. (auth)

36378 SUNSPOTS AND MAGNETOHYDRODYNAMIC FLOWS. Anderson, G. F.; Menzel, D. H. (Harvard Coll. Observatory, Cambridge, Mass.). Int. Astron. Union Symp., No. 35, 142-7 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Theoretical techniques were developed to study compressible, steady-state, magnetically aligned gas flows in sunspot regions. The flows are adiabatic and occur in a known streamline configuration. The nonlinear parabolic partial differential equation describing the flow reduces to an ordinary linear differential equation. The solutions are briefly discussed. (auth)

36379 STATE OF THE PHOTOSPHERE BEFORE THE APPEARANCE OF SUNSPOTS. Korobova, Z. B. (Tashkent

Observatory); Tchandaev, A. K.; Vassil'eva, G. Ya. Int. Astron. Union Symp., No. 35, 151-60(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The object of the investigation was to clarify the behavior of the fluctuations in the brightness in the photosphere on the scale of the supergranulation one to two days before the appearance of sunspots. A detailed photometric treatment and statistical analysis of areas with sizes 100″ × 200″ and 100″ × 100″ were made. Three groups near the center of the disk were studied at 8 moments of their development, using Tashkent daily white-light plates. Printon plates with effective wavelength 4100 Å were used. (W.D.M.)

36380 CORRELATIONS BETWEEN BRIGHTNESS FIELDS AND MAGNETIC FIELDS ON THE SUN. Chapman, G. A. (Univ. of Arizona, Tucson); Sheeley, N. R. Jr. Int. Astron. Union Symp., No. 35, 161-73(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

In places on the solar surface where longitudinal magnetic fields are detectable using Leighton's photographic technique, spectroheliograms taken in the cores of many Fraunhofer lines show a bright photospheric network similar to, but with finer structure than, the familiar chromospheric network visible on Ca^+ K_{232} spectroheliograms. This paper describes preliminary results of a study of the relation between the photospheric network and its associated magnetic fields. (auth)

36381 SUPERGRANULAR PATTERN AND THE STABLE STAGES OF SUNSPOT GROUPS. Dmitrieva, M. G.; Kopecky, M.; Kuklin, G. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Propagation, Irkutsk, USSR). Int. Astron. Union Symp., No. 35, 174-7(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

It is concluded that the sunspots as dark formations appear only at places where the magnetic field has reached a definite critical strength and a definite size. The originating sunspot has a minimal area corresponding to the maximum of the N(S) curve at $S = S_0$ close to the intersupergranular space area. The sunspots are born just in these spaces at the supergranular periphery. The supergranular pattern takes a determining part not only in the active-region structure but also in its evolution. (W.D.M.)

36382 THE INTENSITY, VELOCITY, AND MAGNETIC STRUCTURE IN AND AROUND A SUNSPOT. Beckers, J. M. (Sacramento Peak Observatory, Sunspot, N. Mex.); Schroeter, E. H. Int. Astron. Union Symp., No. 35, 178-86(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

An observational study of the fine structure in a sunspot region led to the following results: (a) The photosphere around a sunspot is covered with the so-called magnetic knots. These features have a diameter of 800 km and a magnetic field of up to 1400 gauss. Although they coincide with dark, intergranular spaces, they are distinctly different from pores. Some 300 surround the sunspot. The magnetic field of the smallest pores were found to be 1500 gauss. (b) For the umbral dots a lifetime of 25 min was found. Their color, as derived from simultaneous observations at 4700 and 6400 Å, was found to be identical to that of the photosphere. Assuming their brightness to be photospheric a diameter of 160 km was derived. (auth)

36383 FINE STRUCTURE OF BRIGHTNESS, VELOCITY, AND MAGNETIC FIELD IN THE PENUMBRA. Mattig, W.; Mehltretter, J. P. (Fraunhofer-Institut, Freiburg i. B.). Int. Astron. Union Symp., No. 35, 187-92(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Spectra were taken under very good seeing conditions, May 29, 1967 of the spot 17°S, 44°W classification J1. The spectrograph slit was set onto the penumbra at the limb's distant side, nearly tangential (deviation 20°) to the solar limb. The best spectrum was analyzed. (W.D.M.)

36384 CONCERNING THE DEVELOPMENT OF THE EVERSHED MOTION IN SUNSPOTS. Altschuler, Martin D.; Nakagawa, Yoshinari; Lilliequist, Carl G. (High Altitude Observatory, Boulder, Colo.). Int. Astron. Union Symp., No. 35, 193-200(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The nonlinear, partial differential equations of magnetohydrodynamics are iterated simultaneously by computer to determine the time development of a single sunspot. Axisymmetry and incompressibility are assumed. The initial conditions are (1) zero velocity everywhere, and (2) the magnetic-field distribution of a ring current embedded in the photosphere. The initial magnetic field is then allowed to relax by magnetic diffusion and by the creation of a velocity field. It is shown that (1) Evershed motion outward from the sunspot will develop from reasonable initial parameters, and (2) the growth rate of the magnetic configuration depends on the strength of the initial magnetic field. (auth)

36385 THE CONNECTION OF FINE-STRUCTURE PHOTOSPHERIC FEATURES IN ACTIVE REGIONS WITH MAGNETIC FIELDS. Steshenko, N. V. (Crimean Astrophysical Observatory, Nauchny, USSR). Int. Astron. Union Symp., No. 35, 201 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The fine structure of the proton sunspot group of July 4–8, 1966 was studied on the basis of high-resolution heliograms. The comparison of the orientation between penumbral filaments and the transverse magnetic fields shows that the direction of the filaments coincides in general with that of the magnetic field. (W.D.M.)

36386 ON THE MAGNETIC-FIELD CONFIGURATION IN SUNSPOTS. Moe, O. Kjeldseth (Univ. of Oslo). Int. Astron. Union Symp., No. 35, 202-10(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

During 1963–67 observations of the magnetic fields in sunspots were obtained at the Oslo Solar Observatory. For the largest spots the detailed distribution of the magnetic-field strength was found. Based on calculations of line profiles made by the author (1967), the direction of the magnetic field was also derived. Observations of the magnetic field of the same spot at several positions on the solar disk give further information regarding the magnetic-field configuration. Results are in fair agreement with those of Bumba (1962). (auth)

36387 THE PROPER MOTIONS OF SUNSPOTS AND THE MAGNETIC FIELD OF ACTIVE REGIONS. Kuklin, G. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Propagation, Irkutsk, USSR). Int. Astron. Union Symp., No. 35, 211-13(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The proper motions in three sunspot groups were studied taking into account the magnetic-field observations (three components) with the help of the solar magnetograph. Conclusions are listed. (W.D.M.)

36388 ON THE STRUCTURE OF THE MAGNETIC FIELD OF SUNSPOTS. Mogilevskii, E. I.; Demkina, L. B.; Ioshpa, B. A.; Obridko, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Int. Astron. Union Symp., No. 35, 215-29(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The model of the magnetic field of sunspots, taking account of fine structure of magnetic field in solar plasma, is considered. Small-scale subgranules with their own field form magnetic filaments in the external current-free field. The filaments are vertical in the umbra, while in the penumbra they run along the surface with sharp bends. In a number of spot umbra the relation between Doppler velocity and the field is established on polarized spectrograms. The π-component splitting in umbra is interpreted as a result of a weak background magnetic-field existence together with a large field of magnetic filaments. Spectrographic definition of the magnetic field in spot umbra is accomplished on the effect of magnetic-lines intensification and directly on spectrograms of low-excitation (Fe I, Ti I) and high-excitation (Fe II) lines. Magnetic field measured in low-excitation lines exceeds twice the field value obtained in high-excitation lines. This result has been considered in the light of the proposed model of sunspot field. (auth)

36389 MAGNETIC AND DOPPLER OSCILLATIONS IN ACTIVE REGIONS. Deubner, F. L. (Fraunhofer Institut, Freiburg i. B.). Int. Astron. Union Symp., No. 35, 230-2(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

With the Capri magnetograph of the Fraunhofer Institute simul-

taneous measurements of sightline velocities and longitudinal magnetic fields were carried out, in order to investigate the dependence of the 300-sec oscillation of sightline velocities on the magnetic-field strengths, and the oscillatory behavior (if any) of the latter. It is concluded that the period of oscillation is independent of the field strength at least up to several 100 gauss. (W.D.M.)

36390 PRELIMINARY COMMUNICATION ON THE SHORT-PERIOD OSCILLATIONS OF SOLAR MAGNETIC FIELDS. Severnyi, A. B. (Crimean Astrophysical Observatory, Nauchny, USSR). Int. Astron. Union Symp., No. 35, 233-5(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

With the image of the Sun held fixed, time variations of solar magnetic fields were recorded simultaneously in two lines (λ 5250 and λ 6103) with the aid of a double magnetograph. The resolution was 2.5″ × 4.5″. The records in both lines 5250 and 6103 covering a time interval of about 1 hr show oscillations with the period ~7.4 min and amplitudes 10 to 20 gauss for moderately active region. (W.D.M.)

36391 SOME COMMENTS ABOUT CORRELATIONS BETWEEN MAGNETIC FIELD AND VELOCITY, MAGNETIC FIELD AND LINE INTENSITY IN THE UNDISTURBED PHOTOSPHERE. Vassil'eva, G. Y. (Pulkovo Observatory, USSR); Tchandsev, A. K. Int. Astron. Union Symp., No. 35, 236-9(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Test cross-correlation functions between the magnetic field recordings and the sightline velocity recordings with east and west relative lag for two regions near the center of the disk were computed. Deviations were found of the absolute value of the magnetic-field strength |H| from the mean absolute value of magnetic-field strength |H| for the whole region. The same procedure for the velocity field was carried out. The cross-correlation functions for these deviations were also computed. (W.D.M.)

36392 ON SOME SPECTROGRAPHIC OBSERVATIONS RELATED TO THE STRUCTURE WITH HEIGHT OF ACTIVE REGIONS AND PARTICULARLY SOLAR FLARES. Oehman, Yngve (Stockholm Observatory, Saltsjoebaden, Sweden). Int. Astron. Union Symp., No. 35, 240-6(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A peculiar kind of double-peaked Hα lines in solar-flare spectra is described. The most likely explanation to this phenomenon is an absorption in the center of the line due to mottles and fibrils situated above the flare. Another explanation might be a rapid rotatory mass motion in the filamentary structure of the flare itself. In some other flare spectra a slight inclination of the Hα-emission streak has been found indicating as well that rotatory mass motions may be present in flares. (auth)

36393 CHROMOSPHERIC HEIGHTS IN ACTIVE REGIONS. Bappu, M. K. V.; Sivaraman, K. R. (Kodaikanal Observatory, India). Int. Astron. Union Symp., No. 35, 247-54(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Spectra, with a radial slit in the K and Hα lines, of a sunspot close to the limb are used to determine chromospheric heights in an active region. Equidensity contours obtained with the Sabattier effect are used to measure the values of h^* for different positions in the line core and wings. The spectra have also been utilized to determine similar heights in two very restricted regions of Ca^+ emission which show an arched emission structure in K_{2V} with bright continuum emission. At the K-line center, unit tangential optical depth in the umbra, umbra–penumbra interface, and penumbra are at 1310, 1610, and 2330 km respectively. The corresponding value for the umbra in the Hα-line center is 1080 km. The arches have a value of h = 3000 km at $\Delta\lambda = 0$ for the K line. (auth)

36394 THE STRUCTURE OF THE LOWER SOLAR CHROMOSPHERE IN UNDISTURBED AND ACTIVE REGIONS. Dubov, E. (Crimean Astrophysical Observatory, Nauchny, USSR). Int. Astron. Union Symp., No. 35, 255-8(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Spectroheliograms taken with the Crimean solar tower telescope in K_{2V} and HΔ filtergrams taken with the chromospheric telescope in Simeis were used in a study of the lower chromosphere structure in undisturbed and active regions. The brightness distributions of the filtergrams and spectroheliograms were compared. (W.D.M.)

36395 PROBLEMS IN THE INTERPRETATION OF POLARIZATION MEASUREMENTS IN ACTIVE REGIONS. Wiehr, Eberhard (Univ., Goettingen, Ger.). Int. Astron. Union Symp., No. 35, 259-60(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Difficulties and uncertainties are discussed concerning the calibration of the response of a solar vector magnetograph (linear and circular polarization degrees) in terms of field strength and angle of inclination of the line of sight using the theory of line formation in magnetic fields (Unno, 1956). (W.D.M.)

36396 ON THE MAGNETIC-FIELD STRUCTURE AROUND FILAMENTS. Ioshpa, B. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Int. Astron. Union Symp., No. 35, 261-6(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The results of an investigation of the magnetic-field structure in the chromosphere around filaments are briefly given. The hypothesis of the existence of a two-field system is suggested. An outer field which has the form of arches and supports the filament against gravity, and an inner one, directed along the filament. (W.D.M.)

36397 THE FORMATION, STRUCTURE, AND CHANGES IN FILAMENTS IN ACTIVE REGIONS. Smith, Sara F. (Lockheed Solar Observatory, Burbank, Calif.). Int. Astron. Union Symp., No. 35, 267-79(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

During periods of good image quality the large-scale films of the Lockheed Solar Observatory obtained during 1966 and 1967 have proven to be especially useful for studying and their relationships to the Hα fine structure observed in active regions. A few well-known aspects of active regions are reiterated. The observed relationships between filaments and plage granules, fibrils, and sunspots are discussed in some detail. (W.D.M.)

36398 PROMINENCES IN ACTIVE REGIONS. Kleczek, J. (Astronomical Inst., Ondrejov, Czech.). Int. Astron. Union Symp., No. 35, 280-1(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Due to stronger magnetic fields in active regions the prominence processes are more violent there than in nonactive regions. Some characteristic processes in prominences of active regions are mentioned. (W.D.M.)

36399 THE DETWISTED PROMINENCE OF SEPTEMBER 12, 1966. Valnicek, Boris (Astronomical Inst., Ondrejov, Czech.). Int. Astron. Union Symp., No. 35, 282-6(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The eruptive prominence of September 12, 1966, is described. Detwisting of two filaments is demonstrated and compared with similar phenomena and with tornado prominences. A short discussion of mechanisms of the origin and subsequent development of the phenomenon is given. (auth)

36400 LOOP-PROMINENCE SYSTEMS AND PROTON-FLARE ACTIVE REGIONS. Svestka, Z. (Astronomical Inst., Ondrejov, Czech.). Int. Astron. Union Symp., No. 35, 287-92(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

It is shown that proton flares and loop-prominence systems form in the same type of active regions. Quite often both these phenomena appear simultaneously, but there are also many cases, when only the proton flare or only the loop-prominence system fully develops. The proton-flare active regions are not randomly distributed on the solar disk, but they tend to occur in complexes of activity which stay on the solar surface for many months and even years. Attention is called to the peculiar clustering of proton-flare regions on the Southern hemisphere, where two sources of activity, at a longitudinal distance of about 180° seemed to move on the solar disk between 1956 and 1962 opposite to the solar rotation, shifting in the longitude at about 70 heliographic degrees per 10 solar rotations. (auth)

36401 BRIGHT POINTS (MOUSTACHES) AND ARCH FILAMENTS IN YOUNG ACTIVE REGIONS. Bruzek, A. (Fraunhofer Institut, Freiburg i. B.). Int. Astron. Union Symp., No. 35, 293-8 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A brief survey is given on the main characteristics of "bright points" and of arch filaments in young bipolar spotgroups. Observations show that both features are closely associated, thus indicating that they have a common cause. It is suggested that the propagation of expanding and increasing active-region magnetic fields through the chromosphere might be that cause. (auth)

36402 SOLAR ACTIVE REGIONS IN Mg II LIGHT. Fredga, Kerstin (Royal Inst. of Tech., Stockholm). Int. Astron. Union Symp., No. 35, 299-303 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

During 1965, two rockets were launched in order to obtain monochromatic pictures of the Sun in the Mg II line at 2802.7 Å. The Mg II filter heliograms were compared with simultaneous Hα and Ca II K spectroheliograms. An important observation from both flights concerns the relative intensities of different active regions. In the Hα pictures there are old fairly faint active regions and newly formed more intense regions. In the Mg II pictures, however, the older regions appear more intense than the younger regions. Different explanations for this intensity-reversal effect were considered. The effect was also looked for in broadband Ca II H filterheliograms, with negative results, however. (auth)

36403 COOPERATIVE STUDY OF SOLAR ACTIVE REGIONS. Michard, R. (Observatoire, Paris-Meudon, France). Int. Astron. Union Symp., No. 35, 307-10 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The general purpose of the cooperative study of Solar Active Regions was to study in detail the evolution of a small number of selected active regions, using the material obtained throughout the world by all techniques of optical and radio astronomy (and possibly also direct information from interplanetary and geophysical effects). A brief introduction to this study is given. (W.D.M.)

36404 FLARE ACTIVITY AND SPOTGROUP DEVELOPMENT. Bumba, V. (Astronomical Inst., Ondrejov, Czech.); Krivskii, L.; Martres, M. J.; Soru-Iscovici, I. Int. Astron. Union Symp., No. 35, 311-17 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The flare activity of all active regions having ten or more flares from August 1959 until December 1961 was investigated. Flare-activity curves drawn with the aid of Kleczek's α index were constructed. The characteristic magnetic situation on the Mt. Wilson synoptic charts of photospheric magnetic fields in which the flare-rich active regions developed is described. A flare activity rate "quantization" was found. From the CSSAR magnetic observational material the reorganization of the magnetic fields of active regions that correlated with sudden changes in the rate of the flare activity was studied. (auth)

36405 A STUDY OF THE LOCALIZATION OF FLARES IN SELECTED ACTIVE REGIONS. Martres, M. J.; Michard, R.; Soru-Iscovici, I.; Tsap, T. (Observatoire, Paris-Meudon, France. Crimean Astrophysical Observatory, Nauchny, USSR). Int. Astron. Union Symp., No. 35, 318-25 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

From the material gathered during the "Cooperative Study of Solar Active Regions," the flare locations in AR magnetic structure and flare relations to changes in the magnetic fields and spot configurations were studied. Besides a confirmation of previous results, it was found that flares are often associated with two features of the spot configuration evolving in opposite senses, one growing, the other declining. (auth)

36406 EVOLUTION OF Ca PLAGES OF THE CSSAR ACTIVE REGIONS. Godoli, G. (Astrophysical Observatory, Catania, Italy); Fossi, B. C. Monsignori. Int. Astron. Union Symp., No. 35, 326-37 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

For each plage of the CSSAR period the daily projected areas were determined and plotted versus time. Also the correction for foreshortening was taken into account. Daily fluctuations of the plage corrected areas, certainly greater than the errors, were found. Also, area fluctuations of shorter periods were observed. (auth)

36407 CORRELATION BETWEEN Ca PLAGES AND LONGITUDINAL MAGNETIC FIELDS OF THE CSSAR ACTIVE REGIONS. Bumba, V. (Astronomical Inst., Ondrejov, Czech.); Godoli, G. Int. Astron. Union Symp., No. 35, 338-45 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The shapes of $K_{3\frac{1}{2}}$ Ca plages and longitudinal magnetic fields are compared for CSSAR active regions during their first transit on the solar disk. The bipolar magnetic regions follow the Hale polarity law. Often the region of inversion of the magnetic field corresponds to a gap in the Ca plage structure. Bright patches of plages may coincide with magnetic inclusions, magnetic hills, and occasionally also with regions of inversion of the magnetic field. The outline of Ca plages follow well the isogauss of 20 to 40 oersted. Histograms of the distances of individual magnetic field intensity peaks do not only correspond to the geometry of the supergranular network but also seem to indicate a difference in the organization of these peaks between the leading and following polarities. (auth)

36408 EVOLUTION OF CORONAL EMISSIONS IN THE COURSE OF THE LIFE OF AN ACTIVE CENTER. Leroy, J. L.; Roesch, J.; Trellis, M. (Observatoire, Pic-du-Midi, France. Observatoire, Nice). Int. Astron. Union Symp., No. 35, 346-55 (1968). (In French).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A study of the development in the solar corona of active centers born during the CSSAR period leads to the following remarks: the "enhancement" of coronal emissions seems to take place first within a localized "core" close to the plage, then to extend to a much larger "halo"; the core from which all the radiations under study originate does not last much more than the spots, whereas the "halo" is characterized by the major importance of the emission at 5303 Å, and lasts as long as the K3 plages. These features can be explained by the assumption that the enhancement is inhomogeneous during the first part of its life, then becomes homogeneous after the core has disappeared. (auth)

36409 OBSERVATION OF STREAMERS AND CONCENTRATIONS IN THE CORONA ABOVE ACTIVE REGIONS. Dollfus, Audouin (Observatoire, Paris-Meudon, France). Int. Astron. Union Symp., No. 35, 359-78 (1968). (In French).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The "K Coronameters" in use since 1956 at Pic-du-Midi and Meudon Observatories for the study of the white-light corona were replaced in 1963 by new improved instruments. The coronal activity was continuously recorded from 1964 to 1967. The electron density in the low corona and its variation with height are summarized by curves and maps. The corona streamers above the proton-flare areas in July and September 1966 are discussed. (auth)

36410 INFLUENCE OF MAGNETIC FIELDS ON THE STRUCTURE OF THE SOLAR CORONA. Newkirk, G.; Altschuler, M. D.; Harvey, J. (High Altitude Observatory, Boulder, Colo.). Int. Astron. Union Symp., No. 35, 379-84 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A current-free approximation to the coronal magnetic field was calculated from measured photospheric magnetic fields (Mt. Wilson) and traced by computer. The calculated field structure was compared to a white-light photograph of the November 12, 1966 eclipse. (auth)

36411 PHOTOGRAPHS OF CORONAL STREAMERS FROM A ROCKET ON MAY 9, 1967. Tousey, R.; Sandlin, G. D.; Koomen, M. J. (Hulburt Center for Space Research, Washington, D. C.). Int. Astron. Union Symp., No. 35, 385-8 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A photograph of the white-light corona from a rocket on May 9, 1967 showed many streamers, all straight and nearly radial, extending across the field of view, 3 to 9$R_\odot$. At the North there were

three spectacular streamers, making angles with the polar axis of 21°E, 20°W, and 27°N. Projected inward, they were radial and passed through the probable positions of the principal plages on the back side. (auth)

36412 ACTIVE REGIONS AND THE INTERPLANETARY MAGNETIC FIELD. Wilcox, John M. (Univ. of California, Berkeley); Ness, Norman F.; Schatten, Kenneth H. Int. Astron. Union Symp., No. 35, 390-4(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The relation of solar active regions to the large-scale sector structure of the interplanetary field is discussed. In the winter of 1963-64 (observed by the satellite IMP-1) the plages density was greatest in the leading portion of the sectors and lesser in the trailing portion of the sectors. The boundaries of the sectors (places at which the direction of the interplanetary magnetic field changed from toward the Sun to away from the Sun, or vice versa) were remarkably free of plages. The very fact that since the first observations in 1962 the average interplanetary field has almost always had the property of being either toward the Sun or away from the Sun (along the Archimedean spiral angle) continuously for several days must be considered in the discussion of large-scale evolution of active regions. Using the observed interplanetary magnetic field at 1 AU and a set of reasonable assumptions the magnetic configuration in the ecliptic from 0.4 to 1.2 AU has been reconstructed. In at least one case a pattern emerges that appears to be related to the evolution of an active region from an early stage in which the magnetic lines closely couple the preceding and following halves of the region to a later stage in which the two halves of the region are more widely separated. (auth)

36413 EXTREME ULTRAVIOLET OBSERVATIONS OF ACTIVE REGIONS IN THE SOLAR CORONA. Burton, W. M. (Culham Lab., Abingdon, Eng.). Int. Astron. Union Symp., No. 35, 395-402(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The coronal features associated with solar active regions can be observed by recording images of the Sun at extreme ultraviolet wavelengths. Pinhole cameras were flown on stabilized sun-pointing "Skylark" rockets to obtain broad-waveband euv solar images. These images show localized emission from high-temperature regions located in the corona above calcium-plage areas. An improved design of pinhole camera, which uses a plane-diffraction grating to give increased spectral resolution, has recorded spectroheliograms in several intense solar lines including He II (304 Å), Fe IX-XI (180 Å), and Si X-XII (50 Å). Estimates are made of the size and brightness of the coronal emission region associated with a developing calcium-plage area. (auth)

36414 THE SOLAR CORONA ABOVE ACTIVE REGIONS: A COMPARISON OF EXTREME ULTRAVIOLET LINE EMISSION WITH RADIO EMISSION. Neupert, Werner M. (Goddard Space Flight Center, Greenbelt, Md.). Int. Astron. Union Symp., No. 35, 404-10(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The observations of extreme ultraviolet emission lines of Fe IX through Fe XVI made by OSO-I were applied to a study of the solar corona above active regions. Ultraviolet and radio emission were determined for several levels of activity classified according to the type of sunspot group associated with the active region. Both radio emission and line radiation from Fe XVI, the highest stage of ionization of Fe observed, were observed to increase rapidly with the onset of activity and were most intense over an E spot group early in the lifetime of the active region. As activity diminishes, radiation from Fe XV and Fe XIV becomes relatively more prominent. Preliminary x-ray data from OSO-III obtained during a flare are introduced. These indicate that radiation from the highest stage of iron thus far observed, Fe XXV, reaches a maximum first in an x-ray burst and that maxima in lower stages of ionization follow, with delays from 2 to 15 min. (auth)

36415 ON SOME ASPECTS OF XUV SPECTROHELIOGRAMS. Tousey, R.; Sandlin, G. D.; Purcell, J. D. (Naval Research Lab., Washington, D. C.). Int. Astron. Union Symp., No. 35, 411-19 (1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A comparison between euv and Ca-K spectroheliograms for 9 dates from 1963 to 1967 showed an excellent correlation between plage intensities in Ca-K and He II 304 Å, except for plages near the limb and a few others. Around the limb all but the highest ionization euv emission lines form a bright ring, usually weaker over the poles. This is an unresolved combination of the limb-brightened emission from the quiet corona and high chromosphere, and emission extending into the corona above plages located as much as several days from limb passage. In Fe XV and XVI only the localized coronal emissions are observed; these vary in form and intensity from line to line. The 171 to 500-Å and white-light coronas, recorded on November 12, 1966, correlate well at low altitudes, but beyond 3′ the euv corona becomes diffuse and without structure. (auth)

36416 SLOWLY VARYING COMPONENT OF SOLAR X RAYS IN RELATION TO THE STRUCTURE OF ACTIVE REGIONS. Michard, R.; Ribes, E. (Observatoire, Meudon, France). Int. Astron. Union Symp., No. 35, 420-30(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The slowly varying component of solar x rays was studied through records of the satellite Explorer-30. Correlations with plage areas, and flux at radiofrequencies were studied. High-flux values at 8 to 20 Å and, still more, at 1 to 8 Å are related to specific ARs, also characterized by great flare productivity, high intensities on 3 cm, and anomalous magnetic structure. (auth)

36417 OBSERVATIONS OF ENERGETIC X-RAYS FROM QUIESCENT SOLAR ACTIVE REGIONS. Acton, Loren W.; Fisher, Philip C. (Lockheed Palo Alto Research Lab., Calif.). Int. Astron. Union Symp., No. 35, 432-8(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A measurement of the solar x-ray spectrum in the 1 to 30-keV interval was made by rocket-borne instruments at 0015 UT on April 5, 1967. These measurements show that the solar x-ray spectrum, which falls off steeply with energy below 4 keV, becomes less steep above this energy. These data are taken to indicate that energetic, nonthermal, electrons are present or continuously produced in quiescent solar-active regions. No optical flare activity was reported for several hours around the time of these observations. (auth)

36418 X-RAY PICTURE OF THE SUN TAKEN WITH FRESNEL ZONE PLATES. Elwert, G. (Univ., Tuebingen, Ger.). Int. Astron. Union Symp., No. 35, 439-43(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Fresnel zone plates were inserted in a rocket-borne pinhole camera on October 4, 1966. The plates were built for the lines of O VI at 34 Å and Si X at 51 Å. The x-ray pictures are compared to Hα-spectroheliograms taken on October 2 and 4, 1966. (W.D.M.)

36419 SIGNIFICANCE OF THE POLARIZATION OF SOLAR SHORT-WAVELENGTH X-RAYS. Elwert, G. (Univ., Tuebingen, Ger.). Int. Astron. Union Symp., No. 35, 444-8(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

For the interpretation of the physical events occurring at the beginning of a flare it seems to be significant not only to observe the spectra of the short-wavelength x radiation but also its polarization. Solar x-ray spectra below 10 Å during flares observed by Bowen et al. (1964), are discussed. (W.D.M.)

36420 ANALYSIS OF SOME SOLAR FLARES FROM OPTICAL, X-RAY, AND RADIO OBSERVATIONS. Falciani, R.; Landini, M.; Righini, A.; Rigutti, M. (Arcetri Observatory, Florence). Int. Astron. Union Symp., No. 35, 451-64(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Using an improved isodensitometric technique it was possible to study in great detail the photometric structure and the evolution of eight flares. A comparison was made between the evolutive curves and the ones obtained from measurements of solar x rays and radio fluxes at 3.2 and 21 cm. A reduction of the flare areas (and of the emitted energies) before the flash phase and a continuous pulsation of the flare have been observed. Further, it seems that the flares associated with radio bursts or x ray events being a very important parameter. The correlation in time between the various examined aspects of the AR seems to indicate that the sequence for the beginning of the different phenomena is, in general: optical flare, x-ray events, and radio events. (auth)

36421 INTERACTION OF MAGNETIC FIELDS AND THE ORIGIN OF PROTON FLARES. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Int. Astron. Union Symp., No. 35, 465-70(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The magnetic model of a proton flare is discussed, in agreement with the known characteristic features of proton-flare development, on the basis of the interaction of an emerging magnetic channel from the photosphere, and its being wedged into the field of an already-existing interaction of two systems of magnetic fields of a complex active region with spots. This explains the origin of the two emission filaments following the splitting and of the "annular" emission filament, entering the corona, connected by a fine loop structure with two split filaments in the chromosphere. The acceleration of particles and their ejection will take place in a number of created "zero line" spaces and in spaces where magnetic lines of force are reconnected. An attempt is made to explain some Hα phenomena in connection with proton flares by means of interactions of magnetic fields in the chromosphere and in the lower corona. (auth)

36422 MODEL OF SOLAR FLARES. Sturrock, P. A. (Stanford Univ., Calif.). Int. Astron. Union Symp., No. 35, 471-9(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A model of solar flares is proposed in which the preflare state comprises a bipolar magnetic-field structure associated with a bipolar photospheric magnetic region. At low heights, the magnetic-field lines are closed but, at sufficiently great heights, the lines are drawn out into an open structure comprising a bipolar flux tube containing a "neutral sheet" or "sheet pinch." Such a sheet pinch is probably related to a coronal streamer. The energy stored in the closed-field regional is derived from photospheric motion whereas energy stored in the open-field region is derived from the nonthermal energy flux which heats the corona and drives the solar wind. The flare itself is identified with reconnection of magnetic field by the tearing-mode resistive instability. If the thickness of the sheet pinch is determined by resistive diffusion and a growth time of the bipolar region of order 1 day, the transverse dimension will be about 10^4 cm. The rise time of the tearing-mode instability is then a few seconds, compatible with the characteristic time of type-III radio bursts. One can understand that the time scale of the reconnection process is of order 10^2 to 10^3 sec if reconnection proceeds by the Petscheck mechanism, with the modification that resistive diffusion is replaced by the more rapid Bohm diffusion. The evolution of a flare, according to this model, appears to fit a number of the observational characteristics of flares. (auth)

36423 HIGH-ENERGY FLARE PLASMA. de Jager, C. (Univ. Observatory, Utrecht). Int. Astron. Union Symp., No. 35, 480-2(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

This note draws attention to certain aspects and problems related to the origin of flare energy, its transformation into magnetic energy, acceleration of particles during the first phase of the flare, and secondary acceleration in a later phase. (W.D.M.)

36424 THE OCCURRENCE AND POSSIBLE MEANING OF THE "NIMBUS". Houtgast, J. (Sterrewacht Sonnenborgh, Utrecht). Int. Astron. Union Symp., No. 35, 483-4(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

There are few observations of cases in which a nimbus has developed around a solar flare of major importance. Speculations have been made about the nature of this obscuring cloud. Some consequences are given of the assumption that one is concerned with scattering by a cloud of electrons, ejected together with the protons during the formation of the flare. (W.D.M.)

36425 FLARE-PRODUCED CORONAL WAVES. Meyer, Friedrich (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Int. Astron. Union Symp., No. 35, 485-9(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A coronal propagation model is presented for fast chromospheric disturbances following flares that were first observed by Moreton and Ramsey, and estimates of average coronal magnetic fields (6 gauss) and disturbance energies ($\leq 10^{29}$ erg) are deduced. (auth)

36426 THE OBSERVATION OF 10 TO 50 keV SOLAR FLARE X-RAYS BY THE OGO SATELLITES AND THEIR CORRELATION WITH SOLAR RADIO AND ENERGETIC PARTICLE EMISSION. Arnoldy, R. L.; Kane, S. R.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). Int. Astron. Union Symp., No. 35, 490-509(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

More than 70 cases of energetic solar flare x-ray bursts were observed by large ionization chambers on the OGO satellites in space. The ionization chambers have an energy range between 10 and 50 keV for x rays, and are also sensitive to solar protons and electrons. A study was made of the x-ray-microwave relationship, and it was found that the total energy released in the form of x rays between 10 and 50 keV is approximately proportional to the peak or total energy simultaneously released in the form of microwave emission. For a given burst the rise time, decay time, and total duration are similar for the 10- to 50-keV x rays and the 3- to 10-cm radio emission. Roughly exponential decay phases are observed for both emissions with time constants between 1 and 10 min. All 3- or 10-cm radio bursts with peak intensity greater than 80 solar flux units are accompanied by an x-ray burst greater than 3×10^{-7} ergs cm^{-2} sec^{-1} peak intensity. The probability of detecting such x-ray events is low unless the radio spectrum extends into the centimetric range of wavelengths. The best correlation between cm-λ and energetic x rays is observed for the first event in a flare. Subsequent structure and second bursts may not correspond even when the radio emission is rich in the microwave component. The mechanism for the energetic x rays is shown to be bremsstrahlung probably of fast electrons on a cooler plasma. If the radio emission is assumed to be synchrotron radiation then a relationship is developed between density and magnetic field which meets the observed quantitative results. One finds, on the average, that 5×10^{-54} joules m^{-2} $(CPS)^{-1}$ of microwave energy at the Earth are required per electron at the Sun to provide the radio emission for the various events. A strong correlation between interplanetary solar-flare electrons observed by satellite and x-ray bursts is shown to exist. This correlation is weak for solar proton events. One may infer a strong propagation asymmetry for solar-flare electrons along the spiral interplanetary magnetic field. (auth)

36427 PROTON FLARE PROJECT. Svestka, Z. (Astronomical Inst., Ondrejov, Czech.). Int. Astron. Union Symp., No. 35, 513-35(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Papers dealing with the proton flare of July 7, 1966 are briefly summarized. The papers were published as Vol. 3 of the IQSY Annals. (W.D.M.)

36428 OBSERVATIONS OF THE SOLAR PROTON EVENT OF AUGUST 28, 1966. Kinsey, J. H.; McDonald, F. B. (Goddard Space Flight Center, Greenbelt, Md.). Int. Astron. Union Symp., No. 35, 536-42(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The Cs I scintillator telescope aboard IMP-III indicated a peak intensity of 6.25 proton/sec cm^2 ster for a SPE (Solar Proton Event) commencing during the period 1600 to 1700 UT on August 28, 1966. This SPE appears to have been associated with the importance 2-3 flare occurring at 22 N/06S at 1522 UT on this date. The comparison of this event to other large proton events occurring during the period May 25, 1965 to September 30, 1966, is made. (auth)

36429 SUNSPOT CHANGES FOLLOWING PROTON FLARES. Sawyer, Constance (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Int. Astron. Union Symp., No. 35, 543-50(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Although the area of some sunspot groups declines suddenly after a flare that produces energetic protons, other groups show a delayed or gradual decline, or continue to grow for several days after the flare. The mean area of sunspot groups that produced flares with polar-cap absorption declines gradually and continuously, beginning within a day after the flare. (auth)

36430 HOMOLOGY OF SOLAR RADIO EVENTS. Fokker, A. D. (Sterrewacht Sonnenborgh, Utrecht). Int. Astron. Union Symp., No. 35, 553-5(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Successive flares within the same center of activity sometimes produce radio events that are remarkably similar. The occurrence of such homologous radio events is commonly restricted to periods of less than 48 hours. Typical for certain centers of activity is their tendency to give rise to impulsive microwave bursts. Such bursts may occur repeatedly during a period of more than a week. The distributions of the lengths of periods during which series of homologous bursts and of impulsive microwave bursts occur are compared. (auth)

36431 SOME RESULTS ON SOLAR ACTIVITY AT 408 MHz. Clavelier, B. (Observatoire, Meudon, France). Int. Astron. Union Symp., No. 35, 556-64(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The first results obtained with the 408-MHz interferometer of Nançay are presented. The typical activity observed at 408 MHz is the "noise storm." With this apparatus multiple centers, generally double, could be distinguished. The comparison of corresponding optical observations with Nançay observations at 169 MHz allowed association of the centers of noise storms at 408 MHz with eruptive centers lying in "anomalous active regions" and description of the schematical structure of active zones. (auth)

36432 CONDITIONS OF ACCELERATION OF SOLAR ELECTRONS, AND DETERMINATION OF THE MAGNETIC FIELD IN THE HIGH CORONA FROM THE CHARACTERISTICS OF A TYPE-IV BURST. Boischot, A.; Clavelier, B. (Observatoire, Paris-Meudon, France). Int. Astron. Union Symp., No. 35, 565-9(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The study of a moving type-IV burst shows that acceleration of electrons can happen in the high corona, and a mechanism is proposed for such an acceleration. The low-frequency cutoff of radio spectrum is interpreted as due to the effect of the coronal plasma upon the synchrotron emission, and this leads to an accurate determination of the intensity of the magnetic field at an altitude of 1 $R_{\odot}$. Then it is possible to compute the energy and the density of the relativistic electrons. (auth)

36433 TENDENCIES TO REPEATING OF TYPE-IVm BURSTS AND THEIR RELATIONS TO THE STAGE OF DEVELOPMENT OF THE SUNSPOT GROUP. Boehme, A. (Heinrich-Hertz-Inst. of Solar Terrestrial Physics, Berlin-Adlershof, Ger.). Int. Astron. Union Symp., No. 35, 570-4(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

It has been shown that moving type-IV bursts at decameter wavelengths are infrequent events compared with the moving type-IV bursts at meter wavelengths. They belong preferably to sunspot groups of relatively homogeneous magnetic structure. Moving type-IV bursts at decameter wavelengths have a very low tendency to repeat. This statement indicates that the magnetic structures producing them have only a short lifetime. The short duration of these bursts cannot be interpreted by radiation damping of high-energy electrons. Furthermore it can be shown that the storm continuum at decameter wavelengths is related preferably to sunspot groups of complex magnetic structure. Probably stationary type-IV bursts at decameter wavelengths are more representative for the acceleration of high-energetic particles than the moving type-IV bursts at decameter wavelengths. (auth)

36434 PROPERTIES OF SOURCES OF THE SLOWLY VARYING COMPONENT OF 2 cm SOLAR RADIO EMISSION. Nagnibeda, V. G. (Leningrad Univ.). Int. Astron. Union Symp., No. 35, 575-80(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

To study the nature of the local sources of solar radio emission connected with active regions, it is important to investigate the structure of such sources and their emission spectra. The results of observations at 2 cm are summarized briefly. (W.D.M.)

36435 SOME PROPERTIES OF THE SOURCES OF SLOWLY VARYING COMPONENT AND OF BURSTS AT 612 Mc/s. Swarup, G.; Kundu, M. R.; Kapahi, V. K.; Isloor, J. D. (Tata Inst. of Fundamental Research, Bombay). Int. Astron. Union Symp., No. 35, 581-4(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A high-resolution 24-element, E-W interferometer situated at Kalyan near Bombay was used to study the sources of slowly varying component of bursts at a frequency of 612 Mc. About 20 slowly varying sources and 11 bursts were observed during the period June 1965 to Feb. 1967. (W.D.M.)

36436 SATELLITE OBSERVATIONS OF SOLAR RADIO BURSTS. Stone, R. G.; Malitson, H. H.; Alexander, J. K.; Somerlock, C. R. (Goddard Space Flight Center, Greenbelt, Md.). Int. Astron. Union Symp., No. 35, 585-7(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

Numerous solar radio bursts were observed with the ATS-II satellite experiment, and although data analysis is still in progress, phenomena being seen are described in a preliminary fashion. The experimental setup is briefly described. (W.D.M.)

36437 COMPARISON OF 8-mm SOLAR RADIO FEATURES WITH LOCAL MAGNETIC FIELDS AND CHROMOSPHERIC FEATURES. Efanov, V.; Moiseev, I.; Severnyi, A. (Crimean Astrophysical Observatory, Nauchny, USSR). Int. Astron. Union Symp., No. 35, 588-93(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The 22-meter radiotelescope of the Crimean Observatory is briefly described. Maps of radioisophotes (in percent of undisturbed background) were obtained for Oct. 24, 25, and 26, 1966, simultaneously with maps of isogauss of longitudinal magnetic fields over the entire disk. (W.D.M.)

36438 RADIO EMISSION OF SPOTGROUPS. Kleczek, J. (Astronomical Inst., Ondrejov, Czech.); Olmr, J.; Krueger, A. Int. Astron. Union Symp., No. 35, 594-7(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

The slowly varying component (SVC) of solar radio emission and burst activity associated with different types of spotgroups from the past solar minimum were investigated statistically. (auth)

36439 SOME RELATIONS BETWEEN SOLAR DECAMETRIC WAVES AND MORPHOLOGICAL CHARACTERISTICS OF ASSOCIATED CHROMOSPHERIC ERUPTIONS. Koeckelenbergh, A. (Observatoire Royal, Brussels). Int. Astron. Union Symp., No. 35, 598-9(1968). (In French).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

This work analyses some correlations or associations between certain features of solar radio bursts at 600 Mc and of associated chromospheric flares respectively. Subject of the analysis are 149 radio events observed at the Humain stain and 125 associated flares observed at Uccle during the years 1957-61. It is found that the radioelectric energy of the bursts is associated with the eruptive area and the Hα intensity of the flares, whereas the duration of the bursts is associated with the Hα broadening. For bursts connected with a second phase, the eruptive area and the importance of the magnetic field have a bearing on the characteristics of the radio event. (auth)

36440 DEVELOPMENT AND STRUCTURE OF AN ACTIVE REGION. de Jager, C. (Univ. Observatory, Utrecht). Int. Astron. Union Symp., No. 35, 602-8(1968).

From International Astronomical Union Symposium on the Structure and Development of Solar Active Regions, Budapest, Hungary. See CONF-670953.

A summarizing review is given for the 89 papers, abstracts, and discussions presented at the conference. The subject is reviewed in terms of large-scale development of the active region, first phase of development. The main phase of development (photosphere, chromosphere, corona, and interplanetary part), flares, last phases of the active region. (W.D.M.)

36441 THE INVISIBLE SUN. Bonnet, Roger-Maurice (CNRS, Paris). Sciences (Paris), No. 56, 22-34(Sept.-Oct. 1968). (In French).

Developments in studies of x-ray spectroscopy of the Sun are examined. Interpretation of solar images recorded at far-uv wavelengths with slitless spectrophotometers is outlined. The coefficient of absorption problem, where the coefficient abruptly in-

creases at 2076 Å, is noted. The discontinuity at 2076Å permits observation without transition from the photosphere to the chromosphere, and can be studied by balloon observation because of a window in atmosphere absorption near 2100Å. Close study of the spectra indicates granulation in the solar atmosphere. A new spectrum of the Mg(I) doublet is presented; it resembles the appearance of the Lyman lines of H, and should be explained by temperature and turbulence effects. The appearance of x rays just before proton emission, with ensuing danger to men in space, suggests that further study in the interpretation of x-ray emission will be of value for safety reasons. (BBB)

36442 SOLAR FLARES. Friedman, Herbert (Naval Research Lab., Washington, D. C.). Astronaut. Aeronaut., 7: 14-21(Apr. 1969).

The nature of solar flares and information that can be gained from them by related physical phenomena are reviewed. For the largest flares, the total optical energy output is about $\frac{1}{30}$th of the total energy radiated by the entire Sun per sec (3.8×10^{33} erg/sec). A still larger amount of energy appears as the kinetic energy of charged particles: the electrons which generate x rays; magnetic-storm plasma clouds; low-energy cosmic-ray protons, which produce polar-cap-absorption effects; and relativistic protons, which reach to energies in the 100-BeV range and can be recorded as ground-level events by neutron monitors. Very large flares usually occur when the sunspots take the configuration of 2 parallel rows of opposite polarities. Typical flare spectra show a predominance of bremsstrahlung continuum emission for energies higher than 1 keV ($\lambda < 10$ Å). These are the x rays that alter the D-region ionization balance and produce ionospheric disturbances. Superposed on the continuum are emission lines of highly stripped ions of Fe, Ca, Si, S, Al, and Mg. X-ray K-emission lines are produced by ionization of the K shells of multielectron ions, and this process requires suprathermal electrons in the >10-keV range. Similarly, high electron temperatures are derived from the shape of the bremsstrahlung continuum. The nature of the nonequilibrium flare plasma is discussed. Protons (E > 12 MeV) are emitted by even the smallest flares (Class 1), and even in the absence of detectable flares from bright plage regions. α particles and heavier nuclei have also been measured in large flares. In some cases, α particles ($4\ He^{++}$) have numbered up to 25% of the proton flux and have constituted half the energy of the particle stream. Solar-flare protons may be hazardous to astronauts, and it is important to know the full spectrum of large flares. The problem of solar-flare development and acceleration of particles to high energies has much in common with astrophysical processes on much greater scales. Some similarities between solar flares and the far-greater outbursts of flare stars, such as UV Ceti, are discussed. (BBB)

Galaxies

36443 (AD-687177) DIRECTION OF THE NEARBY GALACTIC MAGNETIC FIELD INFERRED FROM A COSMIC RAY DIURNAL ANISOTROPY. Schatten, Kenneth H.; Wilcox, John M. (California Univ., Berkeley. Space Sciences Lab.). Apr. 30, 1969. Contract Nonr-3656(26). 17p. CFSTI.

A twenty-year wave in the diurnal anisotropy component of galactic cosmic rays arriving at the Earth from the asymptotic direction 128°E of the Sun has been found by Forbush. This wave is interpreted in terms of enhanced magnetic reconnection between the nearby galactic field and the field lines in the polar regions of the heliosphere during one half of the twenty-year solar magnetic cycle. This interpretation leads to the result that the component parallel to the solar rotation axis of the nearby galactic field is directed northward. (auth) (USGRDR)

36444 MEASUREMENTS OF MAGNETIC FIELDS IN INTERSTELLAR CLOUDS OF NEUTRAL HYDROGEN. Verschuur, G. L. Astrophys. J., 156: 861-74(June 1969).

Measurements of the Zeeman effect in 21-cm spectral lines have revealed magnetic fields of 10 to 20 μgauss (10^{-6} gauss) in the Perseus spiral arm in the direction of Cas A. A field of 3.5 μgauss has been detected in the direction of Tau A, whereas limits of 1, 2.5, and 4.8 μgauss have been set for other regions in the local spiral arm. Magnetic fields in clouds of neutral hydrogen therefore appear to vary by at least an order of magnitude from one region in the Galaxy to another. (auth)

36445 DISTRIBUTION OF H II REGIONS IN IRREGULAR GALAXIES. Hodge, Paul W. (Univ. of Washington, Seattle). Astrophys. J., 156: 847-52(June 1969).

Data on the distribution of H II regions in seven nearby irregular I galaxies are presented in chart and histogram form. The most conspicuous feature common to all is a considerable asymmetry in the distribution, one interpretation of which can be a characteristic pattern of localized bursts of star formation, with a typical size of approximately 1 kpc. (auth)

36446 SPIRAL STRUCTURES OF DISK GALAXIES AS NON AXISYMMETRIC PERTURBATIONS. Yabushita, Shin (Kyoto Univ.). Mon. Notic. Roy. Astron. Soc., 143: 231-44(1969).

Stability analysis of a disk galaxy where centrifugal force balances self-gravitation is carried out using pressure-free hydrodynamical equations. Assuming $e^{in\theta}$ dependence (where θ is the azimuthal angle) of perturbations, the stability analysis is made for n = 1 and 2 by making use of Bessel functions. Linearized equations of motion are transformed into the appropriate eigenvalue problem of linear algebraic equations. A result similar to Lynden-Bell–Ostriker's antispiral theorem is obtained. Numerical results show the general trend that short wavelength perturbations are strongly unstable. Spiral patterns in density are obtained. For n = 2 all the patterns are leading, but for n = 1, both trailing and leading patterns are present. The most unstable pattern has the shortest wavelength and therefore it is the most winding pattern. (auth) (UK)

36447 POSSIBILITY OF GALAXY FORMATION IN THE LEMAITRE MODEL. Byalko, A. V. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl), 9: 293-6(Apr. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 483-6(Apr. 20, 1969).

A classical analysis of perturbations in an infinite gravitating medium with a constant density ϵ and velocity of sound $u = \sqrt{dp/d\epsilon}$ leads to the Jeans criterion, namely, the perturbations that grow exponentially are those with wave numbers smaller than the limiting (Jeans) value $k_J^2 = \kappa\epsilon/2U^2$, ($\kappa$ is Einstein's gravitational constant, c = 1 is the velocity of light). The relativistic analysis of the open and closed models of the universe, made by E. Lifshitz (1946), shows that in the case of expansion the perturbations increase no faster than in a power-law fashion. However, as shown by the author (1968), in the Lemaitre model with a cosmologic constant Λ close to the critical value $\Lambda_c = \sigma_c^{-2}$, near the critical radius $a_c = \sqrt{2/\kappa\epsilon_c}$ (on the plateau), the perturbations increase quite rapidly, and their total growth is proportional to $\Delta^{-1} = \Lambda_c/\Lambda - \Lambda_c \gg 1$. It is shown here that, in this case, the Jeans criterion is also satisfied. (TSS)

36448 NOTES ON IONIZED INTERSTELLAR GAS DISTRIBUTION. Razin, V. A.; Khizhnyakova, I. P. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 479-86(1969). (In Russian).

Three components are singled out in the distribution of ionized interstellar gas in the galactic disc: (1) Strongly rarefied gas with the concentration $N \lesssim 10^{-2}$ cm^{-3} occupying the great part of the volume of the galactic disc. (2) Relatively dense ($N \sim 1$ cm^{-3}) irregularities having the form of filaments or layers oriented along the magnetic field (primarily, parallel to the Galaxy plane) with dimensions of about 30×15 ps in the galactic plane and ~1 ps in the direction perpendicular to it. The mean distance between irregularities in the galactic plane is ~5 to 10 ps and is 5 ps in the direction perpendicular to it, i. e., irregularities occupy about 12% of the volume of the galactic disc. The irregularities form clusters with the dimensions of the order of several hundreds of parsecs. (3) Dense clouds of ionized gas ($N > 1$ cm^{-3}) visible in the optical band and occupying about 0.6% of the volume of the galactic disc. This model of ionized interstellar gas distribution enables explanation of absorption of long-wave cosmic radio emission, depolarization of radioemission from extragalactic discrete sources by the interstellar medium, weak depolarization of the background galactic radiation, and the angular distribution and frequency spectrum of the linearly polarized component of cosmic radio emission. (auth)

36449 NEUTRAL HYDROGEN DISTRIBUTION AND DYNAMICS IN GALAXIES. I. REDUCTION PROCEDURES. Gulin, M.; Weliachew, L. (Observatoire, Meudon, France). Astron. Astrophys., 1: 2-9(Jan. 1969). (In French).

A 15-channel spectrograph for the 21-cm line of neutral hydrogen was used at Nançay with the transit telescope. About 15 nearby galaxies were scanned. M 31 and M 33 were left out of the program owing to a lack in spectral resolution. This first paper outlines the methods adopted for the program. The resolution of the telescope is 4′ in azimuth and 23′ in elevation at zero declination. The channel width is 59 km/s. Observations were performed through an on- and off-source process. The switching rate is 5 m so that several points of the galaxy may be observed during the transit of the source through the one-hour field of the telescope. Profiles were taken every 2′ in right ascension along the major axis. The outputs of the spectrograph were digitized. The data processing was performed on a computer. Starting from model galaxies, profiles were computed to fit the data in the sense of least squares.

A first guess of dynamical parameters is done by rough hand computations. The computer deals with observations from the edge to the center of the galaxy, provides a hydrogen density distribution and refines the rotational parameters. Finally, dynamical and hydrogen parameters are scanned to find the best values of them in the sense of a least-square fit of computed and observed profiles. The computation also provides error estimations through variations of the parameters around the best fit. The model galaxy is a flattened one with circular symmetry. But in case of bad fitting, noncircular models may be computed and expansion terms added to the rotation curve. (auth)

36450 NEUTRAL HYDROGEN DISTRIBUTION AND DYNAMICS IN GALAXIES. 2. STUDY OF THE SPIRAL GALAXY NGC 2403. Guelin, M.; Weliachew, L. (Observatoire, Meudon, France). Astron. Astrophys., 1: 10-18(Jan. 1969). (In French).

In the course of an observing program of hydrogen distributions and dynamics of nearby galaxies, the Sc spiral NGC 2403 was scanned in the 21 cm line with the transit telescope at Nançay. Amongst different series of hydrogen distributions investigated, the best fit to observed spectra is obtained for a gaussian distribution of 20′ width between half-intensity points. The rotation law is given through a Brandt curve with a turnover point radius of 7′ and a maximum rotational velocity of 135 km/s. The shape parameter n of the Brandt rotation curve was found to be 1.5, but its uncertainty is rather large owing to the poor spectral resolution. Within the errors quoted, the hydrogen and velocity models are symmetrical with respect to the center. The ring-shaped neutral hydrogen distribution found by Roberts at Green Bank does not correspond with the results. Model profiles for this ring distribution were computed. Measurements are inconsistent with the results of this computation and seem to rule out any annular distribution for this galaxy. To fit the annular model, the measurements should be at least twice as noisy as they are. This conclusion stands whatever the velocity distribution may be. The total hydrogen mass is 2.5×10^9 $M_\odot$ at a distance of 2.8 Mpc. The evaluated correction for finite optical depth was too small to be applied. The computed total mass (5.5×10^{10} $M_\odot$) is subject to a considerable error in connection with the uncertainty on the n parameter of the Brandt rotation curve. The morphological type of M 33 is very close to that of NGC 2403. However, hydrogen distributions of both galaxies are very different. This suggests an independence of hydrogen distribution with spiral structure. (auth)

36451 OBSERVATIONS OF THE EMISSION LINE $H\alpha$ IN THE NUCLEUS OF THE RADIOGALAXY VIRGO A. Dibai, E. A.; Esipov, V. F. (Shternberg State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 932-5(May-June 1969).

Translated from Astron. Zh., 45: 1177-80(Nov.-Dec. 1968).

Observations were made of the nucleus of the Virgo A radiogalaxy by means of a spectrograph with an electron-optic image converter at the Cassegrainian focus of a 125-cm reflector. Two red emission lines at the wavelengths 6585 and 6606 Å were detected in the spectrum of the nucleus; these lines were identified with the H_α and [N II] λ 6583 lines. The H_α and [N II] emissions, just as the emission in the previously discovered lines [O II] λ 3727, belong to the gas in the nucleus of the galaxy which moves at a velocity of −210 km/sec relative to the nucleus. Estimates are made of the electron density (10 to 20 particles/cm^{-3}) and the mass of the gas ($\approx 10^5$ ⊙). The spectrum is characterized by a high intensity of the forbidden lines relative to hydrogen, just as in the case of the Crab Nebula. The chemical composition of the gas, judging from the [O II] and [N II] lines, is close to normal. (auth)

36452 SPATIAL STRUCTURE OF THE GALACTIC DUST LAYER AND ITS RELATION TO THE APPARENT BRIGHTNESS OF THE MILKY WAY. Uranova, T. A. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 1041-4 (May-June 1969).

Translated from Astron. Zh., 45: 1318-22(Nov.-Dec. 1968).

A study of the photoelectric color excesses of stars in the constellations Aquila and Cygnus indicates that the dust material in the galactic plane is distributed approximately parallel to the inner edge of the optical Cygnus spiral arm and that this tendency is strongest for the densest parts of the dust layer. The thickness of the layer of dust material is greater below than above the galactic equator. By applying mathematical statistics it is found that dark material located closer than 400 to 500 pc from the Sun is responsible for the apparent brightness pattern of the Milky Way in the sector $l^{II} = 32$ to 56°, while it is statistically improbable that more distant parts of the dust layer have much effect. (auth)

36453 THE PLANCK STELLAR VELOCITY DISTRIBUTION III. THE ELLIPSOIDAL APPROXIMATION. Shatsova, R. B. (Rostov-on-Don Teachers' Coll., USSR). Sov. Astron. AJ (Engl. Transl.), 12: 993-9(May-June 1969).

Translated from Astron. Zh., 45: 1254-63(Nov.-Dec. 1968).

An ellipsoidal generalization is considered for the stellar velocity distribution function introduced in Papers I and II of this series. With this function distributions are derived for the velocity components, for their projections on the coordinate planes and the absolute values T of the projections, and for the absolute values v of the space velocity. These distributions are found to represent generalizations of the corresponding isotropic distributions. The differences in the curves for two approximations to f(T) and f(v) are insignificant. The first- and second-order moments, expressed in terms of the parameters C_x, C_y, C_z, are found for all the cases considered. Finite higher-order moments exist only for distributions truncated at high velocities. (auth)

36454 STELLAR MOTION IN THE GRAVITATIONAL FIELD OF CONDENSING INTERSTELLAR GAS. Marochnik, L. S. (Inst. of Astrophysics, Dushanbe, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 1000-3(May-June 1969).

Translated from Astron. Zh., 45: 1264-9(Nov.-Dec. 1968).

A qualitative picture of the increase in dispersion of peculiar stellar velocities through gravitationally condensing clouds of interstellar gas is investigated on the basis of a simple model in which a star moves in a gravitational field which is spatially periodic and exponentially increasing through time. (auth)

Cosmology

Refer also to abstracts 36548, 36853, and 36900.

36455 ON THE EQUATION OF STATE OF A RELATIVISTIC FERMI–DIRAC GAS AT HIGH TEMPERATURES. Topper, Robert F. (California Inst. of Tech., Pasadena). Astrophys. J., 156: 1075-1100(June 1969).

Methods for the calculation of the equation of state of a relativistic Fermi–Dirac gas are developed by considering the analytic properties of integrals over Fermi–Dirac distributions. The equation of state is first considered from a general point of view in order to introduce the relevant integrals and to point out the phenomena of partial degeneracy and electron–positron pair formation, both of which can be important at high temperatures. Using the method of Mellin transforms, the relativistic Fermi–Dirac integrals are expressed as contour integrals. It is shown how these contour integrals give the series of modified Bessel functions and the Chandrasekhar–Sommerfeld asymptotic expansions in the limits of nondegeneracy and extreme degeneracy, respectively. By evaluating the contour integrals using series convergent within the range of integration, representations valid for the case of weak degeneracy are obtained. These expressions reduce to the Chandrasekhal–Sommerfeld expansions in the limit of strong degeneracy. The results are presented as integrals of certain functions, called R-functions, of arguments involving the electron chemical potential ϕ and the temperature parameter $z = mc^2/kT$. These integrals are of such a form that they can be evaluated accurately using Gauss–Chebyshev quadrature. Coefficients for the expansion of the R functions in series of Chebyshev polynomials are tabulated. Using these coefficients one can develop a computer subroutine for generating the R-functions. The analytic properties of the R functions and other associated functions are described. Also described in the paper is an alternative method of calculating the relativistic Fermi–Dirac integrals in the transition region, where $\phi \approx z$, using numerical integration by the trapezoidal rule. This method is superior to other methods of evaluating the integrals directly by numerical quadrature, and is used both as an independent check on the computations involving the R functions and for calculations in the transition region. (auth)

36456 QUASI-STELLAR OBJECTS AND THE DENSITY OF INTERGALACTIC HYDROGEN. Noerdlinger, Peter D. (Univ. of Iowa, Iowa City). Astrophys. J., 156: 841-6(June 1969).

Quasi-stellar objects provide a source of ionizing radiation at redshift $z \approx 2$ considerably in excess of that due to galaxies. Barely plausible models are possible in which each QSO maintains ionization in a region around it sufficient to prevent Ly–a absorption and in which the density at $z = 2$ is a few per million cubic centimeters at any temperature. If Schmidt's law of increase in the number density of QSOs with increasing z is extrapolated to $z \approx 2$, alternative models are possible with similar density and low temperature, but with the medium radiatively ionized throughout the region between the QSOs, not just around each of them. (auth)

36457 SOME IMPLICATIONS OF THE ANISOTROPY MEASURED IN THE MICROWAVE BACKGROUND. Wolfe, A. M. (Univ. of California, San Diego). Astrophys. J., 156: 803-13 (June 1969).

The anisotropy recently measured in the microwave background is interpreted as being induced by the gravitational effects which a large-scale density inhomogeneity has on the radiation. Using the spatially flat Friedmann world model for the substratum, it was found that if the intergalactic gas is ionized and if the quasi-stellar cluster at $z = 2$ is the relevant inhomogeneity, then the latter has a density excess $\delta\rho/\rho \sim 10\%$ and a scale $L \sim 1200$ Mpc. It is shown that an inhomogeneity at $z = 2$, not necessarily characterized by the above density excess and scale, will induce microwave anisotropy in all Friedmann models with deceleration parameters $q_0 > 1/4$ when the intergalactic gas in each of these models is ionized. Some of the theoretical difficulties raised by the small value of the 24-hour component measured in the radiation are discussed, and two future observational tests for these models are suggested. (auth)

36458 GRAVITATIONAL INSTABILITY IN ROTATING SYSTEMS. Genkin, I. L. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 1004-7 (May-June 1969). Translated from Astron. Zh., 45: 1270-4 (Nov.-Dec. 1968).

The influence of rotation on the gravitational instability of a homogeneous medium is discussed. Values for the critical wavelength differing from those obtained by other authors are derived by two methods. (auth)

36459 THE PHOTON EDDY HYPOTHESIS AND THE FORMATION OF PROTOGALAXIES. II. Ozernoi, L. M.; Chernin, A. D. (Lebedev Inst. of Physics, Moscow. Ioffe Inst. of Physics and Tech., Leningrad). Sov. Astron. AJ (Engl. Transl.), 12: 901-8 (May-June 1969). Translated from Astron. Zh., 45: 1137-47 (Nov.-Dec. 1968).

With the hypothesis formulated previously regarding the dynamical character of pregalactic structure as a basis, the generation of density irregularities in a "hot" model Universe is investigated. The pre-Friedmann stage, when the metric properties of space–time are determined by vortical (s) motions, could have been directly followed by a phase of large-scale isotropy and nearly complete homogeneity of density ($\delta\rho/\rho \ll 1$). The potential (p) motions generated by the s motions and the corresponding disturbances in the density would have remained very small so long as the velocities v_s of the s motions were small compared to the sound velocity u in the medium, and the characteristic time t_{sp} for interaction os the s and p motions would have been much longer than the characteristic time t_{exp} of cosmological expansion. During the course of the expansion recombination of the helium–hydrogen plasma would have set in, beginning with the helium and ultimately leading to disengagement of the matter–radiation interaction. The elasticity of the medium, and thereby the sound velocity, would have declined sharply in the process. On scales where v_s was in fact larger than u, with $t_{sp} < t_{exp}$, strong potential motions and density fluctuations $\delta\rho/\rho \approx 1$ would have been generated. After the dissipation of their excess kinetic energy these condensations would have been transformed into gravitationally bound systems (galaxies). On the larger scales the density disturbances would have been comparatively small, and the regular cosmological expansion would not have been completely canceled out. These scales correspond to clusters of galaxies. Hydrodynamic instability is found to constitute the dominant aspect of the proposed mechanism for the formation of pregalactic condensations from the original homogeneous substratum, whereas the role of gravitational instability would have become important only at a relatively late stage, and would then have developed in a nonlinear fashion. (auth)

36460 ABSORBING MATERIAL IN CLUSTERS OF GALAXIES. Karachentsev, I. D.; Lipovetskii, V. A. (Kiev Univ.). Sov. Astron. AJ (Engl. Transl.), 12: 909-12 (May-June 1969). Translated from Astron. Zh., 45: 1148-52 (Nov.-Dec. 1968).

The values $\bar{\tau}_B = 0.20 \pm 0.05$ and $\bar{\tau}_R = 0.07$ for the mean optical thickness of clusters of galaxies in blue and red light are derived from the data in Zwicky's and Abell's catalogs. The mean density of dust material in the Universe is $\rho \approx 2 \cdot 10^{-33}$ g/cm^3. The value $a_B = 0.9 \pm 0.3$ is computed for the metagalactic absorption coefficient $a_B = \bar{\tau}_B/z$. A comparison of these results with the observed absence of appreciable color excesses for distant quasars suggests a nonprimordial origin for intergalactic dust. (auth)

Planetary Phenomena

Refer also to abstract 36520.

36461 HIGH-RESOLUTION INTERFEROMETRY OF VENUS AT 3.12-CM WAVELENGTH. Berge, G. L.; Greisen, E. W. (California Inst. of Tech., Pasadena). Astrophys. J., 156: 1125-34 (June 1969).

The two-element interferometer at the Owens Valley Radio Observatory was used in September 1967 to measure the 3-cm brightness and polarization distributions of Venus near inferior conjunction. The limbs were found to be unpolarized to a very low upper limit. Limb darkening was observed, but no departures from circular symmetry could be detected. Apparently the Venus atmosphere supplies most of the radiation observed at this wavelength. Comparison of the data with model calculations suggests that $1 \lesssim \tau \lesssim 2$. Venus was also observed briefly at 7.5 cm with low resolution. (auth)

Atomic and Molecular Physics

36462 SURFACE AND VACUUM PHYSICS INDEX. Bibliography, Author Index, Subject Index in Alphabetical Order, Subject Index in Logical Order. Volume 4, Number 1, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 128p.

Two hundred and one articles on various aspects of surface and vacuum physics are listed. (M.O.W.)

36463 SURFACE AND VACUUM PHYSICS INDEX. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Volume 4, Number 4, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 136p.

Two hundred and sixty-two articles on various aspects of surface and vacuum physics are listed. (M.O.W.)

36464 SURFACE AND VACUUM PHYSICS INDEX. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Volume 4, Number 3, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 89p.

One hundred and forty-seven articles on various aspects of surface and vacuum physics are listed. (M.O.W.)

36465 ATOMIC PHYSICS. Proceedings of the First International Conference, New York City, June 3–7, 1968. Abstracts. Cohen, Victor W.; zu Putlitz, Gisbert (eds.). New York, Plenum Press, 1969. 162p. (CONF-680648-(Absts.)).

Abstracts of 65 contributed papers presented at the conference are grouped in three sections: fundamental problems, atomic structure, and atomic collisions. (A.G.W.)

36466 ATOMIC PHYSICS. Proceedings of the First International Conference, New York City, June 3–7, 1968. Bederson, Benjamin; Cohen, Victor W.; Pichanick, Francis M. J. (ed.). New York, Plenum Press, 1969. 629p. $25.00. (CONF-680648).

Separate abstracts were prepared for 26 of the 27 papers included. One paper on laser sources was not abstracted. (A.G.W.)

For abstracts of individual papers see: 36340, 36341, 36468, 36476–36484, 36501, 36505–36512, and 36526–36530.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 35461, 35498, 35516, and 37097.

36467 (ORNL-tr-2184) INTERACTION OF BEAMS OF CONDENSED MOLECULES WITH SOLID SURFACES. Becker, E. W.; Klingelhoefer, R.; Mayer, H. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Naturforsch., 23A: 274-9 (1968). 9p. Dep. CFSTI.

The reflection of a beam of nitrogen clusters from a polished stainless steel surface is investigated. The scattered flux shows a strong maximum at an angle of reflection of nearly 90°, independent of angle of incidence. The mean velocity of the reflected beam is about equal to the tangential velocity component of the incident beam. Measurements with increased background pressure demonstrate that the reflected beam still consists essentially of clusters. (auth)

36468 POLARIZED ELECTRONS. Raith, Wilhelm (Yale Univ., New Haven). pp 389-415 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969. From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Techniques for studying polarization effects in low-energy electron experiments and some of their applications are reviewed. Polarization detection by high-energy Mott scattering is described. Sources of polarized electrons include low-energy Mott scattering and photo-ionization of polarized alkali metal atoms. Applications of polarized electrons to studies of spin–orbit and spin–spin interactions and to tracer experiments in which it is desired to

distinguish between sources of electrons are discussed. 94 references. (A.G.W.)

36469 PRODUCTION OF POLARIZED NEGATIVE DEUTERIUM IONS FROM $2S^1/_2$ METASTABLE DEUTERIUM ATOMS. Brueckmann, H.; Finken, D.; Friedrich, L. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 224: 486-500(1969). (In German).

An experimental method for production of polarized negative hydrogen ions is discussed and compared with other methods. The method makes use of the different lifetimes of the metastable $2S^1/_2$ state and the $2P^1/_2$ state of the hydrogen atom. Polarized ion beams are obtained by using a selective quenching process followed by selective ionization. Experimental results are given for the intensity and polarization of a polarized negative ion beam of deuterons. These results were obtained as a function of the quenching field, the magnetic field in the argon cell, and the density of argon and cesium. The yield of negative ions can be expressed by the cross sections for the different charge-exchange reactions in argon. The measured tensor polarization P_{33} can be interpreted as a function of the cross sections, the argon density, and the magnetic field along the beam axis. Beams of 50 nA intensity were produced with a polarization of $P_{33} = -0.250 \pm 0.006$. The main advantage of this method is a low beam emittance; values of of 0.7 cm rad $eV^1/_2$ were achieved. The production of a polarized positive deuteron beam seems to be possible. (auth)

36470 RANGE DISTRIBUTION OF MONOENERGETIC ELECTRONS IN Be AND Al. Tabata, Tatsuo; Ito, Rinsuke; Okabe, Shigeru. Annu. Rep. Radiat. Center Osaka Prefect., 9: 34-9(1968).

Differential range distributions of electrons in Be and Al were measured for incident energies from 4.1 to 15 MeV. The most probable range R_m, the practical range R_p, the maximum range R_0, the mean projected range $\bar{R}$, and the range straggling ΔR were determined from the distributions observed. In the energy region considered, R_m, R_p, and R_0 for Be and Al can be represented by the equation $R = AE_0 - B$, where E_0 is the energy of the electron. The values of R_p for Al show a good agreement with those given by Katz and Penfold's empirical relation for the maximum range of β rays, as already reported by Harder and Poschet. The same semiempirical relation between $\bar{R}$ and theoretical mean range L as that recently established by one of the present authors for absorbers of atomic number greater than 6 has been found to hold also in the case of Be. (auth)

36471 RANGE-ENERGY RELATIONS OF LOW-VELOCITY HEAVY IONS IN PLASTIC VISUAL DETECTORS. SPECIAL STUDY OF FISSION FRAGMENTS. Ralarosy, J.; Schmitt, R.; Mosinski, G.; Tripier, J.; Debeauvais, M.; Stein, R.; Remy, G. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 30: 1-13(Jan. 1969). (In French).

To study the kinematic and mechanism of fission at high energy, two kinds of plastic visual detectors, cellulose nitrate and makrofol, were used. These studies require the knowledge of analytical relations between the particle momentum (or energy) and the particle range in the plastic. First, theoretical relations were determined and experimental verification made. A calculation method is presented giving particle range versus velocity in plastic detectors. These relations and the knowledge of experimental α-particle range lead to momentum range relations for ions heavier than α particles. A special calculation concerning fission fragments leads to simple mathematical relations; all necessary experimental fits were made. (auth)

Atomic and Molecular Properties

Refer also to abstracts 36307, 36311–36313, 36356, 36505, 36677, 36696, and 36815.

36472 (CERN-Trans-68-11) METHOD OF SOLUTION OF THE WAVE EQUATION BY ADDITIVE POTENTIAL. Rezanov, A. N. Translated into French by E. Osteletsky (CERN, Geneva, Switzerland), from a Russian report. 5p. (In French). Dep.

An additive potential method is proposed for the solution of the wave equation which allows an expression for E and ψ to be formulated without recourse to hypotheses having a model character on the properties of the U_1 and U_2 potentials. The method proposed can be easily generalized for application to the case of many particles or of many partial potentials. (J.S.R.)

36473 (LA-4106-tr) TABLES OF ATOMIC WAVE FUNCTIONS. Brattsev, V. F. (Akademiya Nauk SSSR, Moscow. Matematicheskii Institut). Translated by Margaret Y. Prince (Los Alamos Scientific Lab., N. Mex.). Science Publishing House, Moscow-Leningrad, 1966. 72p. Dep. CFSTI.

Atomic wave functions have been calculated and tabulated for the elements helium through argon, singly and doubly ionized, by the Hartree–Fock–Slater self-consistent-field approximation. The development and applications of that approximation are described. (auth)

36474 (ORNL-tr-2156) ON THE EXISTENCE OF A MAXIMUM PRINCIPLE AS AN EQUIVALENT FORMULATION OF THE THOMAS–FERMI–DIRAC MODEL AND THE TFD-INTERACTION POTENTIAL OF ATOMS. Guenther, K. Translated for Oak Ridge National Lab., Tenn., from Ann. Phys. (Leipzig), 14: 296-309(1964). 20p. Dep. CFSTI.

A maximum principle formulated by Abrahamson and others as an equivalent formulation of the Thomas–Fermi–Dirac model for neutral (not necessarily spherical-symmetrical) electron systems is investigated for its behavior with respect to variations of the electron cloud surface. It is found that the extreme value identical to the energy is not a maximum. The variation principle therefore is not suited for an approximate energy calculation by means of variation laws, since the correct surface is not known in cases of practical interest. Beyond this, it is shown that the interaction potentials of atoms calculated by Abrahamson with this maximum principle also cannot be correct because of another forbidden step in the theory. A lower bound is indicated for the numerical value of the resulting error. (auth)

36475 INTERFERENCE BETWEEN COHERENT EMISSIONS IN THE MEASUREMENT OF ATOMIC LIFETIMES. Macek, Joseph (Univ. of Nebraska, Lincoln). Phys. Rev. Lett., 23: 1-2(July 7, 1969).

It is pointed out that the (zero-field) oscillations seen in the decay curves for atoms excited by beam-foil collisions may be due to interference of light from different fine-structure levels; the interference can only be seen, however, if light of different polarizations is detected with different sensitivity. (auth)

36476 DOUBLE RESONANCE AND LEVEL-CROSSING SPECTROSCOPY. zu Putlitz, Gisbert (Yale Univ., New Haven. I. Physikalisches Institut der Universitaet Heidelberg). pp 227-64 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

The uses of optical double resonance and level crossing in high-resolution spectroscopy of excited atomic states are surveyed. Each method is described briefly. Applications and experimental results are discussed under the following headings: atomic properties (fine structure separations, lifetimes of excited states, g_j values, Stark shift parameters), atomic interactions with radiation and particles (interaction with rf fields and light, collision processes involving excited atoms), and atomic interactions with nuclei (hyperfine structure and nuclear moments, core polarization in atoms, isotope shifts of spectral lines). (A.G.W.)

36477 RADIATIVE TRANSITIONS. Dalgarno, A. (Harvard College Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). pp 161-98 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Quantitative studies of single-photon radiative transitions between atomic states are reviewed. 193 references. (auth)

36478 COHERENCE. Scully, Marlan O. (Massachusetts Inst. of Tech., Cambridge). Contract SD-90. pp 81-102 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

A general discussion of coherence in atomic and radiation physics is followed by a review of some of the more recent theoretical and experimental investigations relating to the quantum theory of coherence. The Hanle effect, the implications of coherence in an N-particle system, the concept of superradiance, photon echo, and the phenomenon of self-induced transparency are considered. The general framework of the quantum theory of optical coherence is outlined, and the coherence properties of laser radiation as derived from the quantum theory of an optical maser are discussed. It is concluded that deeper insights into the quantum theory of optical coherence have led to an enrichment of experimental techniques. (A.G.W.)

36479 QUANTUM ELECTRODYNAMICS: THEORY. Drell, S. D. (Stanford Linear Accelerator Center, Calif). pp 53-69 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

The present status of the theory of quantum electrodynamics is reviewed. Theoretical predictions are compared with experimental measurements of the Lamb shift, hyperfine structure, and the gyromagnetic ratio of the electron and muon. Various sources of uncertainties and difficulties in calculations are pointed out, but no serious challenges to the basic structure of quantum electrodynamics are seen. 32 references. (A.G.W.)

36480 QUANTUM ELECTRODYNAMICS: EXPERIMENT. Hughes, Vernon W. (Yale Univ., New Haven). pp 15-51 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

The status of dynamic tests of quantum electrodynamics is reviewed. Specific topics covered include the Lamb shift for hydrogenic atoms, the fine structure constant α, the g values of the electron and the muon, the hyperfine structure and annihilation rates of positronium, the hyperfine structure of muonium, vacuum polarization for muonic atoms, and the fine structure of He. It is concluded that conventional quantum electrodynamics has so far survived all tests without any clear violation. 71 references. (A.G.W.)

36481 PRECISE SCHROEDINGER WAVE FUNCTIONS FOR TWO-ELECTRON ATOMS. Schwartz, Charles (Univ. of California, Berkeley). pp 71-9 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

The history of work on the ground-state wave function and energy of the isoelectronic sequence of two-electron atoms is reviewed. Current work on the fine structure of the 2^3P state of He is discussed. It is concluded that the goal of measuring and calculating the fine structure of He to an accuracy of about one part in 10^6 is not impossible but is not in sight. (A.G.W.)

36482 DOUBLY EXCITED STATES OF ATOMS. Fano, U. (Univ. of Chicago). pp 209-25 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

In this review of doubly excited states of atoms, discussion is centered on He**, but the general significance of each item of information is considered. Double excitation spectra, interchannel transition processes, and selection rules applicable to He are discussed. (A.G.W.)

36483 HYPERFINE STRUCTURE. Stroke, H. H. (New York Univ.). pp 523-50 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Some recent experimental and theoretic developments in the study of hyperfine structure (hfs) are reviewed. New techniques of hfs measurement are surveyed, and some hfs-anomaly data are tabulated. Information on both atomic and nuclear structure gained from atomic hfs studies is discussed. 90 references. (A.G.W.)

36484 MAGNETIC HYPERFINE ANOMALIES. Foley, H. M. (Columbia Univ., New York). pp 509-22 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Observable effects of the finite size of the charge distribution and of the distribution in spin and orbital magnetism in the nucleus on hfs interactions in atoms are reviewed. A nonrelativistic discussion of the theory of hyperfine interaction for distributed magnetism is presented, and its predictions are compared with experimental results of various investigators. Special cases of μ-mesic atoms and deuterium and tritium are considered. (A.G.W.)

36485 QUASI-BOUND STATES IN H_2. Allison, A. C. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Chem. Phys. Lett., 3: 371-3(June 1969).

A new method for the easy determination of quasi-bound states is proposed. The method is used in a discussion of the two observed quasi-bound levels in molecular hydrogen. (auth)

36486 INTEGRAL TRANSFORM FUNCTIONS: A SIMPLE NON-EXPONENTIAL ORBITAL FOR THE He SERIES. Somorjai, R. L. (National Research Council of Canada, Ottawa). Chem. Phys. Lett., 3: 395-7(June 1969).

Calculations were carried out on the He isoelectronic series with a simple, two-parameter Laplace transform kernel that has a nonexponential transform. Accuracy close to that of Hartree–Fock calculations was obtained. A physically plausible criterion for selecting kernels is given. (auth)

36487 THE s-LINE IN THE L-SPECTRUM OF Dy. Nigam, A. N.; Garg, K. B. (Univ. of Rajasthan, Jaipur, India). Chem. Phys. Lett., 3: 398(June 1969).

A 20-cm curved mica crystal spectrograph of the transmission type was used to study the extreme alpha region of the L spectrum of dysprosium. A new diagram line at $\lambda = 2023.4$ X.U. corresponding to the quadrupole transition $L_{III}\,M_{III}$ (s) is reported for the first time. (auth)

36488 CALCULATION OF THE MULTIPLET FACTOR FOR MORE COMPLICATED TRANSITIONS IN LS COUPLING. Dekker, Elly (Astronomical Inst., Utrecht). Astron. Astrophys., 1: 72-6(Jan. 1969).

The transition probability for allowed transitions is equal to the square of the reduced matrix element of the electric-dipole operator which can be written as the product of a line factor, a multiplet factor, and a transition integral. A formula is presented for the multiplet factor for transitions of the type $l_1^{q}\,l_2^{m} \rightarrow l_1^{q-1}\,l_2^{m+1}$ in L–S coupling. Using this expression, the multiplet factor for more complicated transitions was also calculated. (auth)

36489 SPECTRAL LINE BROADENING DUE TO ATOMIC COLLISIONS. Roueff, E.; Van Regemorter, H. (Observatoire de Paris, Meudon, France). Astron. Astrophys., 1: 69-71(Jan. 1969).

The width of spectral lines due to collisions with hydrogen atoms does not rise from the Van der Waals dispersion forces but from a shorter interaction. (auth)

36490 MOLECULAR SCHROEDINGER EQUATION. IX. SQUARE AND RECTANGULAR STATES OF H_4 AND THE MOLECULAR IONS H_4^{3+} AND H_4^{2+}. Conroy, Harold; Malli, Gulzari (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 50: 5049-65(June 15, 1969).

Our method for the solution of the molecular Schrödinger equation has been further developed and extended to the case of the four-electron system. Ab initio calculations are presented, which lead to the electronic wave functions and energies of square and rectangular forms of H_4. As a preliminary to the four-electron studies, the energies and wave functions for a number of states of the ions H_3^{+} and H_3^{+} are calculated. Complete contour maps for the potential-energy surfaces of these systems are reported and the H_4 surface is discussed in connection with the bimolecular isotope exchange reaction $H_2 + D_2 \rightarrow 2HD$. Contour maps for the electron density distribution in square and rectangular H_4 are presented and discussed. (auth)

36491 INTERACTION OF TWO METASTABLE TRIPLET HELIUM ATOMS. Klein, D. J. (Univ. of Texas, Austin). J. Chem. Phys., 50: 5151-7(June 15, 1969).

Ab initio quantum-mechanical calculations have been performed for the $^5\Sigma_g^+$, $^3\Sigma_u^+$, and $^1\Sigma_g^+$ states arising from the interaction of two $1s2s^3S$ helium atoms. A rigorous upper bound to the quintet potential was found by use of the variational principle. Crude estimates of the auto-ionizing singlet and triplet states were obtained by the "stabilization" method. The quintet-state potentials exhibit a van der Waals minimum, and the triplet and singlet potentials exhibit more substantial minima. The behavior of the wave functions in the separated-atom limit was studied, and the range of applicability of the effective Heisenberg spin Hamiltonian was tested on the calculated potentials. (auth)

36492 SCREENING CONSTANTS AND TRANSITION ENERGIES. Veigele, Wm. J. (Kaman Nuclear, Colorado Springs, Colo.); Stevenson, D. E.; Henry, E. M. J. Chem. Phys., 50: 5404-7(June 15, 1969).

Atomic screening constants usually are derived by minimizing ground-state energies or by comparing known system energies with those calculated with simple wave functions containing screening constants. One set was derived, however, by matching moments of simple wave functions containing screening constants to moments of Hartree–Fock wave functions. These screening constants represent the individual interactions of a given electron with each of the other electrons of the system. They are, therefore, particularly useful for calculating bound–bound and bound–free transition energies in ions. Neutral atom electron binding energies calculated using these screening constants disagreed with published best values. The screening constants were adjusted empirically to reproduce closely these best values of binding energies. When the adjusted screening constants were used to calculate K- and L-shell

transition energies in neutral atoms and ions, good agreement with accepted values was obtained. (auth)

36493 HYPERFINE STRUCTURE AND g_J VALUES OF LOW LEVELS OF ^{159}Tb. Childs, W. J.; Goodman, L. S. (Argonne National Lab., Ill.). J. Opt. Soc. Amer., 59: 875(July 1969).

Extension of hfs studies of ^{159}Tb to higher levels of $4f^96s^2$ and to two levels of $4f^86s^2$ is reported. Measurements were made by standard atomic-beam magnetic-resonance techniques. Values of the magnetic-dipole hfs constants A, the electric-quadrupole hfs constants B, and the electron g factors g_J for ten states not previously studied were obtained. These values are compared with other results and possible errors are considered. (A.G.W.)

36494 ENERGY-DEPENDENT SLATER INTEGRALS. Wilson, Michael; Fred, Mark (Argonne National Lab., Ill.). J. Opt. Soc. Amer., 59: 827-9(July 1969).

Data are presented from Hartree-Fock calculations and from empirical level fitting showing a linear decrease with energy in the various radial integrals that describe Coulomb repulsion and spin-orbit interaction of atomic electrons. (auth)

36495 DETERMINATION OF THE LIFETIME OF THE $d^3\Pi_u$ STATE OF H_2. Cahill, Patrick (Columbia Univ., New York. Polytechnic Inst. of Brooklyn). J. Opt. Soc. Amer., 59: 875-6 (July 1969).

A single-photon-counting technique was used to measure the lifetime of the $d^3\Pi_u$ electronic state of molecular hydrogen excited by an electron beam. The lifetimes of the first three vibrational levels, corresponding to the Q transitions of the Fulcher band system ($d^3\Pi_u - a^3\Sigma_g$), were found to be 68 ± 5, 58 ± 5, and 62 ± 5 nsec. These transitions correspond to the wavelengths 6018, 6122, and 6224 Å, respectively. (A.G.W.)

36496 SOME DIABATIC (QUASI-STATIONARY) STATES OF SMALL DIATOMIC SYSTEMS: PROJECTED ATOMIC ORBITALS. O'Malley, Thomas F. (General Research Corp., Santa Barbara, Calif.). J. Chem. Phys., 51: 322-34(July 1, 1969).

It has been recognized, both from experiment and from theory, that the diatomic potential curves followed by colliding atoms are frequently not those of the conventional stationary adiabatic states. The actual states, which have been named "diabatic," are most easily understood as adiabatic states that are quasistationary rather than stationary. In the work reported here, several methods (those of Holoeien, Lipsky-Russek, and Feshbach), which were developed for atoms, are applied in an exploratory manner to calculate quasi-stationary electronic states of some small diatomic systems. The potential-energy curves calculated are those for $H_2(^1\Sigma_{g,u})$ and also $HeH^+(^1\Sigma)$, $He_2^+(^2\Sigma_g)$, and $He_2(^3\Pi_u)$. It was found that the method of Holoeien and of Lipsky and Russek, when applied to molecules, gave results that were satisfactory and physical for all R's, and generally superior to that of Feshbach. A new and simpler method, using projected atomic orbitals in a valence-bond wave function, was also developed. Aside from their direct usefulness for simple processes such as differential elastic scattering and symmetric charge transfer (a numerical application is made to double charge transfer in H^-H^+ collisions), these diabatic states each form the nucleus of a quasi-adiabatic representation of the electronic Hamiltonian, from which inelastic, charge-changing, and rearrangement collisions involving these systems can be calculated most directly and precisely. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 36480, 36981, and 37253.

36497 (CEA-R-3804) POSITRON ANNIHILATION IN SOLIDS: POSITRONIUM DIFFUSION. Paulin, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 122p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

The existence of two slow components in lifetime spectra of positron annihilation in silicon, aluminum, and alkaline-earth oxide powders is established. These two long mean lives, $\simeq 10^{-9}$ sec and $\simeq 10^{-7}$ sec, result from annihilation, inside and outside the grains, respectively, of orthopositronium formed in defects present in ionic crystals investigated. Dynamic behavior of Ps, so revealed, is analyzed in terms of diffusion in excellent agreement with experiment. Diffusion constants of the order of 10^{-4} cm^2 sec^{-1} and mean paths before annihilation from 50 to 300 Å are measured. From 100 to 500°K the temperature influence on the diffusion process is effective only in SiO_2 where the activation energy is found to be about 10^{-2} eV. The p-Ps zero-point energy evaluated by angular correlation gives the order of magnitude for defect dimensions and diffusion mean time. Finally, o-Ps behavior in space between grains, where only its interaction with atmospheric gases can be detected, is analyzed. (auth)

36498 (LNF-69/5) DIFFUSION OF THE SYSTEM (μ^-p) IN GASEOUS HYDROGEN. Note No. 428. Matone, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). June 27, 1969. 44p. (In Italian). Dep.

It was experimentally shown previously that the kinetic energy of (μp) during its formation is about 0.55 eV and that at atmospheric pressure and room temperature there is a rapid thermalization process, which carries the (μ^-p) to the singlet ground state in a time of ~30 nsec. In the present study these results are verified analytically. The calculations are extended to the case of very low H_2 pressures so as to give a complete description of the diffusion process of the system. The treatment is divided into two parts: in the first is discussed the scattering of the system on free protons and in the second the calculation is extended to (μ^-p) + H_2 → (μ^-p) + H_2 scattering taking into consideration both the hyperfine structure of the system and the rotational and vibrational levels of the H_2 molecule. (J.S.R.)

36499 MUONIUM IN MAGNETIC FIELD. Gurevich, L. I.; Ivanter, I. G.; Makarina, L. A.; (and others) (Inst of Atomic Energy, Moscow). Phys. Lett., 29B: 387-90(June 9, 1969).

The effect was discovered of modulated muonium μ^+-spin precession (beats) in a magnetic field. The beat frequency being proportional to the magnetic field square, made it possible to find the magnitude of the muonium ground state hyperfine splitting in a medium. (auth)

36500 SHIFTS OF ANNIHILATION RADIATION ENERGY FROM THE ELECTRON REST MASS ENERGY FOR POSITRONS ANNIHILATING IN COPPER AND SODIUM. Varlashkin, P. G.; Zganjar, E. R. (Louisiana State Univ., Baton Rouge). Nucl. Phys., A130: 182-94(1969).

The reasons for not expecting the energy of annihilation radiation to exactly equal the electron rest mass energy when annihilation takes place in bulk matter are discussed. It is shown that directional correlation measurements on the two-photon annihilation process enable one to calculate the shift from the electron rest mass energy for positrons annihilating in simple metals. Specific results are presented for positrons annihilating in copper and sodium. The Doppler broadening of the annihilation radiation is also discussed. (auth)

36501 MESIC ATOMS. Telegdi, V. L. (Univ. of Chicago). pp 551-80 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Processes involved in the formation of mesic atoms are described. Electric monopole effects and quantum electrodynamic effects in the structure of mesic atoms are discussed. Techniques for determination of isotope and isomer shifts in mesic atoms are reviewed, and some illustrative results are given. 40 references. (A.G.W.)

36502 S-STATE MATRIX ELEMENTS FOR MUONIC MOLECULES. Carter, Benjamin P. (Univ. of California, Livermore). J. Comput. Phys., 4: 54-66(June 1969).

Coordinates ξ, η, θ are introduced, one of which is the internuclear distance, and all of which are linear combinations of interparticle distances in a molecular three-body system. Each matrix element of the Hamiltonian or unity is shown to be the sum of a few products of reduced matrix elements, which are one- or two-dimensional integrals, provided that each basis function is the product of a function of ξ and η times a function of θ. For basis functions that are products of mononomials times exponentials in ξ, η, θ, the reduced matrix elements are represented as linear combinations of basic integrals, for which closed-form or recursive expressions are derived. (auth)

36503 ENERGY LEVELS AND WAVE FUNCTIONS OF PIONIC ATOMS. Krell, M.; Ericson, T. E. O. (CERN, Geneva). Nucl. Phys., B11: 521-50(1969).

Present data on strong interaction shifts and widths in pionic atoms are analyzed in terms of a nonlocal effective potential with five parameters. Realistic mass and charge distributions are used and strong interaction effects on the vacuum polarization are included. The dependence of predictions on parameters is discussed; properties of the wave functions are presented for different assumptions of the interaction. The effective potential predicts a change of the attractive p-wave interaction to a repulsion in the region $Z \approx 36$. It also suggests important isospin effects in the gradient interaction for very heavy nuclei. The Born approxima-

tion of the real isovector part of the potential is in agreement with soft pion theory; this term, as well as the entire real potential, is also close to multiple scattering theory. The analysis suggests that the isoscalar πN amplitude is $-0.01\mu^{-1} \lesssim a_N^{(+)} \lesssim 0$. The absorptive potential is about a factor of two stronger than predicted. (auth)

Collision Phenomena

Refer also to abstracts 36468, 36478, 36498, and 37354.

36504 ANGULAR DISTRIBUTIONS OF ELASTICALLY SCATTERED ELECTRONS FROM HYDROGEN. Tai, H.; Teubner, P. J.; Bassel, R. H. (Univ. of Pittsburgh). Phys. Rev. Lett., 22: 1415(June 30, 1969).

Experimental data on angular distribution of electrons scattered from hydrogen are compared with the predictions of Glauber theory. (auth)

36505 rf SPECTROSCOPY OF STORED IONS. Dehmelt, H. G. (Univ. of Washington, Seattle). pp 475-86 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Techniques for study of atomic systems by use of collisions of state-selected projectiles with ions stored in a trap are illustrated by several examples. Diagrams of the apparatus used, including ion-storage devices, are included. Possibilities for future applications of the technique are discussed briefly. (A.G.W.)

36506 COLLIDING BEAMS. Dunn, Gordon H. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). pp 417-33 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Techniques using crossed, merging, and inclined beams to study particle collisions are reviewed and compared. Advantages, disadvantages, typical systematic errors, and ways in which results from one technique influence others are considered. It is concluded that conventional thermal-atom-projectile crossed-beam techniques continue to appear best for differential and exchange scattering studies. The crossed-charged-beams technique has demonstrated a relatively high degree of accuracy in absolute measurements. The merging-beams technique dramatically extends the logarithmic energy range accessible, and energy resolution at low energies is improved. (A.G.W.)

36507 COLLISIONS OF LIGHT WITH ATOMS. Franken, P. A. (Univ. of Michigan, Ann Arbor). pp 377-87 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

The suitability of ordinary electromagnetic theory and simple quantum mechanics for the treatment of the phenomena of resonance fluorescence and the photoelectric effect is discussed. It is concluded that it is unnecessary to introduce the photon concept into many familiar calculations and descriptions of modern atomic physics. (A.G.W.)

36508 HEAVY-PARTICLE COLLISIONS. Smith, Felix T. (Stanford Research Inst., Menlo Park, Calif). pp 353-76 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Collisions involving two atoms or ions in the energy range above the thermal one, particularly from a few eV upward, are reviewed. Processes discussed include elastic scattering and inelastic processes involving electronic excitation, ionization, and electronic energy or charge transfer. Emphasis is on the types of measurements now being made; illustrative examples are given. The simple theoretical concepts that can be used for their interpretation are also considered. 38 references. (A.G.W.)

36509 REARRANGEMENT COLLISIONS. Watson, Kenneth M. (Univ. of California, La Jolla). pp 333-52 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Rearrangement collisions involving two initial particles and two final particles are reviewed. Various theories, approximations, and calculational methods are discussed, including the Born approximation, the classical theory developed by Gryzinski, the method of perturbed stationary states, the coupled-state approximation, the Feshbach formalism, and the Faddeev–Weinberg equations. The proton–hydrogen charge-exchange reaction is considered in some detail. 46 references. (A.G.W.)

36510 RESONANCES IN ELECTRON–ATOM COLLISIONS. Schulz, G. J. (Yale Univ., New Haven). pp 321-31 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Some features of experimental progress in the study of structure in elastic and inelastic cross sections in the energy range below the ionization threshold are reviewed. Such structure is associated with the formation of compound states of atoms consisting of the incident electron and the target atom. Results obtained for rare gases, atomic hydrogen, H_2, and N_2 are surveyed. It is concluded that, although compound states have been established in essentially all atoms examined and have been studied also for diatomic and complex molecules, the techniques available to date give information only about compound states in a very limited range of lifetimes. (A.G.W.)

36511 ELECTRON COLLISIONS WITH POSITIVE IONS. Seaton, M. J. (University Coll., London). pp 295-319 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Aspects of collision theory important in the study of electron–ion collisions are reviewed: expansions in powers of the reciprocal of the nuclear charge, quantum defect theory and the analysis of resonance structures, approximation methods, techniques of calculation, isoelectronic sequences, and recombination. Results obtained in recent work are discussed. 65 references. (auth)

36512 THEORY OF ELECTRON–ATOM COLLISIONS. Burke, P. G. (Queen's Univ., Belfast). pp 265-94 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

The development of methods for making calculations relating to collisions of electrons with atoms is reviewed. Elastic scattering, and excitation and ionization processes in inelastic scattering are discussed. Some specific results are included as illustrations. 66 references. (A.G.W.)

36513 DISSOCIATION OF OXYGEN MOLECULES DURING O_2–O_2 AND O_2–O COLLISIONS. Losev, S. A.; Shatalov, O. P. (Moscow Univ.). Dokl. Akad. Nauk SSSR, 185: 293-5(Mar. 11, 1969). (In Russian).

The high efficiency of dissociated O atoms and O_2 molecules in the dissociation of O_2 at temperatures of 3000 to 7000°K in comparison with the efficiency of argon atoms has been reported by a number of observers. However it is not safe to extrapolate the results to temperatures >10,000°K. Hence shock tube experiments were carried out in 10% O_2 + 90% Ar. Absorption spectrometry was used to measure the concentration of molecular oxygen in the gas behind the shock-wave front. The dissociation of oxygen molecules was found to follow Beer's law (the absorption decreased with increasing molecular dissociation). The adsorption ability in the zone of nonequilibrium dissociation behind the shock-wave front depends on the concentration of oxygen molecules, the gas density, and the temperature. With the aid of computer calculations the following values are recommended for values of the dissociation rate constants: (1) for the O_2–O reaction the value of K1 = $(1 + 108\ \theta^{-0.58} \exp[-1.7 \times 10^{-3}\theta^{3.3}])\ k\ (O_2\text{–Ar})$ for $\theta > 4$, and (2) for the $(O_2$–$O_2)$ reaction the value of K2 = $(1 + 600\ \theta^{-2.3} \exp[-4 \times 10^{-6}\ \theta^{9.2}])k(O_2\text{–Ar})$ for $\theta > 3$. Here $\theta = T°K/1000$. In this case $k(O_2\text{–Ar})$ is the rate constant for O_2 dissociations caused by collisions with Ar atoms. (TTT)

36514 EXCITATION TO THE METASTABLE STATES AND IONIZATION FROM GROUND AND METASTABLE STATES IN HELIUM. MEASUREMENTS WITH CROSSED ATOMIC AND ELECTRON BEAMS. Vriens, L.; Bonsen, T. F. M.; Smit, J. A. (Univ., Utrecht). Physica, 40: 229-52(Dec. 13, 1968).

A crossed-beam apparatus was designed, the new aspect of which is that an atomic beam is subsequently crossed by two parallel electron beams. The first electron beam produces metastable atoms, which are then ionized in the second beam. In this way the energy dependence of the cross sections for ionization of He from the metastable 2^3S and 2^1S states was measured. These measurements require a high ion-detection efficiency. The high sensitivity of the apparatus also made possible measurement of cumulative ionization within one electron beam (and of excitation to the 2^3S and 2^1S states of He) and (2) very accurate measurement of the

cross section for direct ionization from the ground state. The effect of thermal energy spread in the electron beam on the latter experimental results was reduced by mathematical unfolding techniques. For direct ionization from the ground state of He, the following threshold dependence of the cross section Q_i (in 10^{-16} cm^2) on the electron energy E_e (in eV) was obtained: $Q_i = (8.6 \pm 0.5) \times 10^{-3} (E_e - 24.58)^{1.13 \pm 0.02}$ for $24.58 \text{ eV} \leq E_e \leq 27.1 \pm 0.3$ eV, and $Q_i = 0.0125 [E_e - (25.14 \mp 0.04)]$ for $27.1 \pm 0.3 \text{ eV} \leq E_e \leq 34$ eV. These formulas agree with experiment within the experimental uncertainty. (auth)

36515 LINEAR COLLISION OF A CLASSICAL HARMONIC OSCILLATOR WITH A PARTICLE AT HIGH ENERGIES. Secrest, Don (Univ. of Illinois, Urbana). J. Chem. Phys., 51: 421-5 (July 1, 1969).

The collision of a harmonic oscillator with a particle is studied classically. All three particles are constrained to lie in a line. A soft exponential interaction and a rigid sphere interaction are considered and the connection between these two interactions is investigated. A relation is given between the hardness of the interaction potential, the oscillator force constant, and the collision energy. Nonmonotonicity of the energy transfer at high energies is shown to be related to multiple collisions. (auth)

36516 EMISSION CROSS SECTIONS OF THE FIRST NEGATIVE BAND SYSTEM OF N_2 BY ELECTRON IMPACT. Aarts, J. F. M.; De Heer, F. J.; Vroom, D. A. (FOM-Instituut voor Atoom-en Molecuulfysica, Amsterdam). Physica, 40: 197-206 (Dec. 13, 1968).

Cross sections have been measured for the emission of the first negative band system of N_2 when excited by electrons in the energy range of 0.1 to 6 keV. In particular the v'' progressions with the $v' = 0$ and 1 levels have been investigated. The emission cross sections can be analyzed by application of the Bethe–Born approximation. A relatively strong contribution from collision-induced dipole transitions is found in the excitation process. The energy behavior of all vibrations is the same. The total emission cross sections of both v'' progressions account for 12.5% of the total ionization cross sections of N_2. Comparison is made with existing electron, proton, and photon impact data. (auth)

36517 MEASUREMENTS OF Q VALUES FOR Al^+, P^+, S^+, Cl^+, K^+, AND Mn^+ ON ARGON AT keV ENERGIES. Fastrup, B.; Hermann, G. (Univ. of Aarhus, Denmark). Phys. Rev. Lett., 23: 157-9(July 28, 1969).

Inelastic-energy-loss distributions for single collisions of Al^+, P^+, S^+, Cl^+, K^+, and Mn^+ with argon at keV energies have a triple-peaked structure in a limited range of τ_0 similar to that observed earlier for the homonuclear case Ar^+ on Ar. In contrast to the homonuclear case, however, the inner-shell excitation for the asymmetric cases takes place almost exclusively in the one of the collision partners with lowest atomic number Z. (auth)

36518 ANGULAR DEPENDENCE OF COLLISION-INDUCED EXCITATION OF H_2^+ IONS. Gibson, D. K.; Los, J.; Schopman, J. (FOM–Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 40: 385-98(Dec. 30, 1968).

The angular dependence of the dissociation cross section of H_2^+ ions incident at 3 to 10 keV on rare gases and H_2 was measured. The results show qualitative agreement with theoretical predictions and also that for small internuclear distances in the H_2^+ molecule the dissociation proceeds primarily from the $2p\sigma_u$ state. For these internuclear distances the largest departure from the predicted curves is interpreted as a simultaneous excitation of projectile and target atom. The relative dissociation cross section as a function of the H_2^+ internuclear distance was also measured. These measurements reveal evidence for a resonance excitation process. (auth)

36519 EXCITATION OF HELIUM BY 0.05 TO 6 keV ELECTRONS AND POLARIZATION OF THE RESULTING RADIATION. Moustafa Moussa, H. R.; De Heer, F. J.; Schutten, J. (FOM–Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 40: 517-49(Jan. 20, 1969).

Absolute cross sections have been determined for excitation of helium to n^1S (n = 3, 4, 5, and 6), n^1P (n = 2, 3, 4, and 5), n^1D (n = 3, 4, 5, and 6), n^3S (n = 3, 4, and 5), n^3P (n = 3, 4, and 5) and n^3D (n = 3 and 4) levels by 0.05- to 6-keV electrons, and the light intensities of the resulting spectral lines have been determined. The measurements have been carried out at low gas pressures to avoid all the effects due to collisional excitation transfer and the absorption of resonance radiation. The polarization of the resulting radiation has also been measured. The same apparatus has been used as before in ionization experiments, where detailed attention has again been paid to the elimination of disturbing effects caused by secondary electrons. Only small modifications were necessary for the observation of light. As far as the relative energy dependence is concerned, the experimental singlet excitation cross sections obey the asymptotic energy dependence predicted by the Bethe or Born theory. For ^1S and ^1D levels deviations from the Born energy dependence start at impact energies below about 1000 eV and for ^1P levels below about 400 eV or possibly at a lower energy. As far as the absolute values of the singlet excitation cross sections are concerned, in the energy region where the Born approximation is valid, the agreement between experiment and theory varies from a few percent to about 50%, dependent on the level. The experimental polarization of $n^1P - 2^1S$ is in reasonable agreement with the Born calculations; for $n^1D - 2^1P$ there is no agreement. Cross sections for singlet excitation of helium by electrons are compared with those for protons. At large impact velocities they become almost equal. In the case of triplet excitation, no agreement has been obtained with the Ochkur approximation; the cross sections decrease more slowly with increase of impact energy than E_{el}^{-3}. (auth)

36520 INFRARED EMISSION SPECTRA OF SOME MOLECULAR GASES EXCITED BY FAST ELECTRONS. Koval, A. G.; Danilevskii, N. P.; Koppe, V. T.; Fogel, Ya. M. (Gorky State Univ., Kharkov). Sov. Astron. AJ (Engl. Transl.), 12: 1045-9 (May-June 1969).

Translated from Astron. Zh., 45: 1322-5(Nov.-Dec. 1968).

The emission spectra of the gases CO, CO_2, NO, CH_4, NH_3, and H_2O excited by 13-keV electrons were investigated in the wave length range 6,500 to 11,500 Å. The CO and CO_2 spectra are compared with the spectra of these gases excited by protons. (auth)

36521 INITIAL IONIZATION OF HYDROGEN IN A STRONG SHOCK WAVE. Belozerov, A. N.; Measures, R. M. (Univ. of Toronto). J. Fluid Mech., 36: 695-720(May 19, 1969).

A theoretical and experimental investigation was made of the initial ionization processes in a strong shock wave in hydrogen. The relaxation length for ionization, which is principally determined by the rate of excitation, was measured and from a comparison with the theory an estimate was obtained for the cross section for atom–atom excitation collisions. Detailed theoretical calculations showed that the electron temperature approaches to within 1% of the atomic temperature in a distance that is small compared with the total relaxation length for ionization. This enabled considerable simplification, for it indicated that a single-temperature model could be used in calculating the theoretical relaxation profile over the experimental range of operating conditions. An electromagnetic shock tube, with a Philippov pinch to create the driver plasma, was employed to produce shock waves of the required velocity. The ionization behind the shock front was studied by means of a double-frequency Mach–Zehnder interferometer, with a ruby laser and a K.D.P. crystal as the light source. A close agreement between the theoretical and experimental electron-density profiles behind the shock front was obtained for small relaxation lengths, when the cross section for the atom–atom excitation collisions was assumed to be about 7×10^{-2} times that of the corresponding cross section for electron–atom excitation collisions. (auth) (UK)

36522 HIGHER BORN APPROXIMATIONS FOR ELASTIC ELECTRON SCATTERING FROM ATOMS. Dudenhausen, Wolf-Dieter (Univ., Tuebingen, Ger.). Z. Naturforsch., 24a: 747-61 (May 1969). (In German).

A theorem analogous to the unitarity relation by Glauber and Schomaker is derived for Born's approximations. For a given potential $\Phi(r) = \mu(\hbar^2/2m)\, V(r)$ of the scattering atom the n-th approximation f_n for the scattering amplitude is defined as the function resulting from the n-th iterative step of Born's approximation. If $|f_n|^2$ is expanded into a series of powers of the parameter μ, this series up to terms in μ^{n+1} is defined as the n-th approximation for the differential cross section $d\sigma_n/d\Omega$, and not $|f_n|^2$ itself. In this case an extension of the optical theorem $\text{Im } f_{n+1}(0) = (k/4\pi)\, \sigma_n$ can be derived. For a potential $\Phi(r) = -(Ze^2/4\pi\epsilon_0 r) \cdot \exp(-r/R) \sum a_i r^i$ exact analytic expressions for the scattering amplitude f_n and the differential cross section $d\sigma_n/d\Omega$ can be given in first and second Born approximations. An important example is the hydrogen-like atomic potential in which, in contradistinction to Wentzel's model, the electron density Q(r) is limited even for $r \to 0$. For this model, the differential scattering cross section in second Born approximation exceeds the values of the first approximation for all scattering angles, while experimental data indicate a correction of the opposite sign. An estimate of the cross sections in third approximation shows that they are again below the first approximation. These results indicate that the Born's first approximation is not only less complicated but even more accurate than the second one. The absolute values of the scattering amplitudes in first and second approximations diverge considerably even at high energies, mainly because of the imagi-

nary part $\mathrm{Im}f_2(\vartheta)$ of $f_2(\vartheta)$. Therefore, conclusions on the phase $\eta(\vartheta)$ from $\mathrm{Im}f_2(\vartheta)$ do not seem to be reliable. (auth)

36523 ELECTRON-BEAM ROTATIONAL TEMPERATURE MEASUREMENTS INCLUDING THE EFFECT OF SECONDARY ELECTRONS. Lillicrap, D. C.; Harvey, J. K. (Imperial Coll. of Science and Tech. London). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 980-2(May 1969).

It is suggested that discrepancies between experimentally measured rotational temperatures and values calculated on the assumption that the only important mechanism producing the $B^2\Sigma_u^+$ states of N_2^+ was direct excitation from the ground state by fast electrons are primarily due to excitation by secondary electrons. An expression for the relative intensities of lines in the R branch of the first negative system is derived, which includes the contribution from the secondaries. The validity of the expression is verified by comparison with the experimental data of Ashkenas [Phys. Fluids, 10: 2509 (1967)]. (A.G.W.)

36524 TOPICS IN ATOMIC COLLISION THEORY. Geltman, Sydney. Pure and Applied Physics. A Series of Monographs and Textbooks. Volume 30. New York, Academic Press, Inc., 1969. 254p. $13.00.

A thorough treatment of the application of quantum scattering theory to low-energy atomic collision phenomena is divided into three main areas: static field scattering, electron–atom collisions, and atom–atom collisions. Emphasis is on those topics and methods that contribute most significantly to the understanding of the physics and to the calculation of reliable cross sections. (A.G.W.)

36525 APPLICATION OF ION CYCLOTRON RESONANCE TO THE STUDY OF INELASTIC EXCITATION BY LOW-ENERGY ELECTRONS. Ridge, Douglas P.; Beauchamp, J. L. (California Inst. of Tech., Pasadena). J. Chem. Phys., 51: 470-1(July 1, 1969).

Ion cyclotron resonance spectroscopy was used to study the spectrum of N_2 excited by electrons of energies up to 20 eV. The technique involved the addition of 0.1% CCl_4 to the N_2, conversion of low-energy electrons to Cl^-, and monitoring the Cl^- produced as a function of electron energy. The results show several well resolved excitation peaks, the positions and intensities of which are in excellent agreement with previous studies. (A.G.W.)

Atomic Theory

Refer also to abstract 36814.

36526 INVARIANCE AND SYMMETRY PRINCIPLES. Feinberg, G. (Columbia Univ., New York). pp 1-14 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Contributions from experiments in atomic physics to the understanding of invariances and symmetries of physical laws are summarized. The classical invariances under Lorentz transformations and under translations in space and time are reviewed. The discrete symmetries T, C, and P, which are known to be violated in the weak interactions, are then discussed. Charge equalities and charge conservation are considered briefly. The advantages of the precision possible in atomic measurements and the dangers in generalizing these results too hastily to other situations are pointed out. (A.G.W.)

36527 ATOMIC STRUCTURE, TRANSITION PROBABILITIES, AND THEORY OF ELECTRON CORRELATION IN GROUND AND EXCITED STATES. Sinanoglu, Oktay (Yale Univ., New Haven. Orta-Dogu Teknik Universitesi, Ankara). pp 131-60 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

The significance of electron correlation in atomic structure calculations is reviewed, and a method for treating correlation effects is outlined. It is shown that, in closed-shell systems, the N-electron correlation problem can be split into $N(N-1)/2$ helium-like decoupled pair problems. In nonclosed-shell states, three types of correlation effects are distinguished, and their special properties are used to evaluate them for classes of atoms and ions. Results of calculations of electron affinities and transition probabilities by this method compare favorably with experimental results. (A.G.W.)

36528 MANY-BODY THEORY OF ATOMIC STRUCTURE. Brueckner, Keith A. (Univ. of California, San Diego). pp 111-30 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

The idealized many-body problem of electrons at high density moving in a weak or uniform external field is reviewed. Comparison of the resulting correlation energies with experimental atomic correlation energies indicates that the atomic problem cannot be successfully approached from the starting point of the high-density electron gas and that a study of the special features of the atomic problem is essential. (A.G.W.)

36529 VARIABILITY OF ATOMIC CONSTANTS. Dicke, R. H. (Palmer Physical Lab., Princeton, N. J.). pp 103-9 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Suggestions made by various people since 1928 on the possible variability of atomic constants are reviewed. It is shown that a variation of the fine structure constant α in space or time due to a long-range scalar field seems a very unlikely possibility unless the variation is extremely small. (A.G.W.)

36530 SYMMETRY PROPERTIES OF ATOMIC STRUCTURE. Judd, B. R. (Johns Hopkins Univ., Baltimore). pp 199-208 of Atomic Physics. Bederson, Benjamin (ed.). New York, Plenum Press, 1969.

From 1st International Conference on Atomic Physics, New York. See CONF-680648.

Applications of group theory to atomic structure dating from the 1949 article of Racah (Phys. Rev., 76: 1352(1949)) and involving the use of continuous groups are reviewed. The determination of higher groups and the evaluation of matrix elements are considered. In a survey of current problems, the following are discussed briefly: introduction of new groups, new sequences of groups, accidental zeros, plethysms, and classification of operators. (A.G.W.)

36531 PHASE-INTEGRAL APPROXIMATION IN MOMENTUM SPACE AND THE BOUND STATES OF AN ATOM. II. Gutzwiller, Martin C. (Columbia Univ., New York). J. Math. Phys. (N. Y.), 10: 1004-20(June 1969).

The phase-integral approximation of the Green's function in momentum space is investigated for a particle of negative energy (bound state), which moves in a spherically symmetric potential. If this potential has a Coulomb-like singularity at the origin, it is shown that any two momenta can be connected by an infinity of classical trajectories with a fixed energy. The summation of the usual phase and amplitude factors over these trajectories is the approximate Green's function. If there is orbital precession, there are not only poles along the negative energy axis, but also weaker singularities, which are not examined in detail. The poles are found at the energies given by the semiclassical quantum conditions: angular momentum = $(l + \frac{1}{2})\hbar$ and action integral for the radial motion = $(n + \frac{1}{2})2\pi\hbar$, where l and n are integers ≥ 0. The residues at these poles give the approximate bound-state wave functions as a product of the asymptotic formula for Legendre polynomials with the asymptotic solution of the radial Schrödinger equation. It is conjectured that the occurrence of poles in the approximate Green's function is a direct consequence of the periodic character of the classical motion. (auth)

36532 EXPANSION OF THE DENSITY MATRIX OF AN N-FERMION SYSTEM IN TERMS OF THE CORRELATION DENSITIES OF FERMION CLUSTERS. Shibuya, Tai-ichi; Sinanoglu, Oktay (Yale Univ., New Haven). J. Math. Phys. (N. Y.), 10: 1032-7(June 1969).

The N-fermion density operator $D = |\Psi\rangle\langle\Psi|$ is decomposed into the densities of clusters of correlating fermions. The m-body cluster densities $\hat{\gamma}^{(m)}$ are orthogonal to the one-body Fock–Dirac-type densities ρ_1, i.e., $\mathrm{Tr}_1(\rho_1\hat{\gamma}^{(m)}_{1,2,\ldots,m}) = 0$. The reduced-correlation-density matrices obtained differ from the conventional reduced-density-matrices and are particularly convenient for the treatment of fermion–fermion correlations. (auth)

36533 ALGEBRAIC MATRICES FOR THE CONFIGURATIONS $(d + s)^n p$. Roth, C. (McGill Univ., Montreal). J. Math. Phys. (N. Y.), 10: 1038-44(June 1969).

The construction of the algebraic matrices for the configurations $(d + s)^n p$ in L–S coupling is discussed. Particular emphasis is given to configurations with a half-filled d shell. From a total of 42 parameters specifying the various interactions for the configurations $(d + s)^n p$ only the matrices of 8 parameters need to be calculated explicitly for the complementary configurations $(d + s)^n p$, $n > 6$. The matrices of the other 34 parameters can be obtained from the corresponding algebraic matrices of $(d + s)^n p$, $n \leq 6$, either directly or by simple changes in sign. (auth)

36534 NATURAL ORBITAL EXPANSION OF INTERACTING GEMINALS. Silver, David M. (Ames Lab., Iowa. Harvard

Univ., Cambridge, Mass.). J. Chem. Phys., 50: 5108-16 (June 15, 1969).

An antisymmetrized product of "interacting" geminals is proposed for the form of a many-electron wave function. The interacting geminals are given a natural orbital expansion where the natural orbitals of the geminals are also natural orbitals of the total wave function. This ansatz is more general than the strongly and weakly orthogonal geminal and identical geminal models and includes them as particular cases. However, the use of the interacting geminal wave function is not significantly more complicated for the purpose of calculations. Different constraints on the geminal occupation coefficients define the various geminal models and more than one model can be incorporated into a single wave function. The case of two singlet pairs of electrons is examined in terms of the interacting geminal model; density matrices, energy expressions, and variational equations are given. (auth)

36535 QUASICLASSICAL APPROXIMATION FOR THE OSCILLATOR STRENGTH AND EFFECTIVE CROSS SECTIONS OF RADIATIVE TRANSITIONS. Bureeva, L. A. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 962-6(May-June 1969).

Translated from Astron. Zh., 45: 1215-21(Nov.-Dec. 1968).

Equations are derived for the oscillator strength and the photoionization and photorecombination cross sections in the quasiclassical approximation, for transitions from (or to) the n, l level of the hydrogen atom. For the total probabilities of radiative processes (not partitioned with respect to l), the Kramers approximation is refined. (auth)

36536 SYMMETRY OF TWO-PARTICLE SCALAR OPERATORS FOR $(d + s)^N$ CONFIGURATIONS. Feneuille, S. (CNRS, Orsay, France). J. Phys. (Paris), 30: 325-35(April 1969). (In French).

Symmetrized, scalar and hermitian, two-particle operators are defined from basic monoelectronic double tensors, for $(d + s)^N$ configurations. From these, a complete set of independent two-particle operators having well-defined symmetry properties in each of the groups $Sp_{12} \supset SU_2 \times \{R_s \supset R_3\} \supset R_3$ is constructed explicitly. (auth)

36537 QUANTUM-MECHANICAL DESCRIPTION OF COHERENT SPONTANEOUS EMISSION. Bonifacio, R.; Preparata, G. (Harvard Univ., Cambridge, Mass.). Nuovo Cim., Lett., 1: 887-93(June 11, 1969).

The general problem of coherent spontaneous emission of a system of N two-level atoms coupled to a single-mode electromagnetic field is considered. The initial state is assumed to have definite population difference M and co-operation number J; no photon is initially present. An attempt is made to give a full quantum solution, at least in the case where the co-operation number J is much larger than 1. (L.B.S.)

36538 DIPOLE SHIELDING TENSOR. Epstein, Saul T.; Johnson, Robert E. (Univ. of Wisconsin, Madison). J. Chem. Phys., 51: 188-9(July 1, 1969).

An exact formula is derived for the dipole shielding tensor of an atom in an arbitrary time-dependent field. Conditions are given under which a variational calculation will yield similar results. (auth)

Cosmic Radiation

Refer also to abstracts 36344, 36443, and 36889.

36539 (AD-686795) RADIOACTIVITY OF SOME UNUSUAL CELESTIAL ENERGY SOURCES. Final Scientific Report. Haymes, Robert C. (Rice Univ., Houston, Tex. Dept. of Space Science). Apr. 18, 1969. Contract F44620-67-C-0062. 6p. (AFOSR-69-1045-TR). CFSTI.

Research conducted to discover whether gamma radiation emanates from various celestial objects is described. Radiation at photon energies between 30 and 570 keV was detected from several galactic sources and from one beyond the Milky Way during the balloon-borne experiments. The significance of these, the first observations conducted at wavelengths that include those associated with radioactivity, is that they may help explain how the generation and violent release of energies equivalent to the annihilation of one hundred million solar masses occurs in natural sources. (auth) (USGRDR)

36540 (HASL-209) LOW-ENERGY ATMOSPHERIC GAMMA RADIATION AS A MEASURE OF COSMIC-RAY SECONDARY ELECTRON FLUX. Lowder, Wayne M. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). June 1969. 35p. Dep. CFSTI.

The method described for determining the secondary electron flux from low-energy gamma-ray measurements will be useful in investigations of the properties of the cosmic radiation field within the atmosphere. A quantitative relation between the omnidirectional positron (and total electron) flux and 0.51-MeV annihilation photon flux is derived, applicable to atmospheric depths >50 g/cm^2. This relation can be used to calibrate any experimental measure of low-energy photons, produced primarily by electron bremsstrahlung, in terms of total electron flux. Gamma-ray data from two balloon flights were used to determine an absolute electron flux profile throughout the atmosphere that is consistent with existing experimental data. (auth)

36541 STOCHASTIC VARIATIONS OF COSMIC RAYS IN THE SOLAR SYSTEM. Jokipii, J. R. (Univ. of Chicago). Astrophys. J., 156: 1107-16(June 1969).

The response of the cosmic-ray intensity in the solar system to turbulent fluctuations in the solar wind is calculated. The cosmic-ray diffusion coefficient k and the wind velocity V vary stochastically about their mean values, and the variations are assumed to be frozen into the solar plasma. The resulting fluctuations in the cosmic-ray intensity I are determined to first order in the fluctuations of k and V by solving the full time-dependent Fokkel–Planck equation and regarding all three fluctuations as stationary random functions of time. The results, expressed in terms of autospectra and cross-spectra of I, V, and k (at a given heliocentric radius r) depend on distant as well as local features of the solar-wind turbulence and may therefore serve as a sensitive probe of the structure of plasma turbulence in the solar wind. This technique may permit an estimate of the distance to the boundary of the modulating region (that heliocentric radius beyond which there is little turbulence). Power spectra which were computed from counting rates obtained by the Climax neutron monitor in 1965 show some evidence of enhanced fluctuations at a frequency of 0.15 cycles per day. The theory would predict a peak at this frequency if the boundary of the modulating region were at 2.7 ± 0.5 AU. This tentative estimate of the size of the modulating region is consistent with, and independent of, previous estimates. (auth)

36542 EFFECT OF TRANSVERSE VARIATION OF SOLAR WIND SPEED ON COSMIC RAYS. Newman, Robert C. (Franklin Inst., Swarthmore, Pa.). Planet. Space Sci., 17: 909-16 (May 1969).

The effect of the variation of solar-wind speed with solar latitude on the cosmic-ray intensity observed at the Earth is examined by means of a simplified mathematical model. It appears that semiannual intensity variations of several per cent should occur for cosmic rays with rigidities below a few GV. (auth) (UK)

36543 DAY-TO-DAY VARIATION OF COSMIC-RAY DIURNAL VARIATION AND INTERPLANETARY MAGNETIC FIELD. Kodama, Masahiro (Inst. of Physical and Chemical Research, Yamato, Japan). Rikagaku Kenkyusho Hokoku, 45: No. 2, 34-42(Mar. 1969). (In Japanese).

Studies of day-to-day variation of cosmic-ray diurnal variation were performed on the basis of the 24 h harmonic dial for the meson and neutron components measured at Deep River. The data were those obtained from May 1962 to December 1964, corresponding to a descending period of the solar cycle. A series of 27-day summation dials consisting of a combination of the first harmonic vectors of both components are illustrated. It is found from these diagrams that the diurnal variation is not always stable throughout the whole period but occasionally highly modulated with a quasi periodicity of one half of the solar rotation period. A close relationship between the diurnal variation and the four-sector structure, which was found from the magnetic field observation by IMP-1 satellite, is established. As for the other solar rotation periods, a similar response is investigated. (NSA of Japan)

36544 ANOMALOUS X RAYS OBSERVED ON EXPLORER 30. Maeda, Rikio (Radio Research Lab., Ibaraki, Japan). Denpa Kenkyusho Kiho, 15: 16-22(Jan. 1969). (In Japanese).

X-ray signals from Explorer 30 received at Kokubunji, Tokyo, Japan, during the period from December 1965 to September 1966 often overflowed the photometric thresholds and brought no direct information on radiation flux. There are two types of anomalous saturation in the 1- to 8-Å ionization chamber aboard the satellite. One type is found in geomagnetically quiet middle and low latitudes when the solar x rays are enhanced. In these cases, response intervals for 1- to 8-Å x rays are unusually elongated and abnormal increase is detected in a harder range 0.5 to 3 Å. The other type is apt to appear consecutively at times of main phases of geomagnetic storms in high latitudes, caused by atmospheric x rays originating from bremsstrahlung produced by precipitating electrons. Such x rays are also observed in a softer range 6 to 16 Å and based as background noises to the solar x rays. (NSA of Japan)

36545 COSMIC-RAY RECORDS AND INTENSITY VARIATIONS DURING COSMIC-RAY STORMS. Oestman, Bo. Abstracts of Uppsala Dissertations in Science, No. 129. Uppsala, Univ. of Uppsala, 1969. 9p.

Thesis.

Meson telescopes using plastic scintillators as detectors and having a counting rate of about one million counts per hour were constructed. Cosmic-ray decreases recorded during the years 1957 through 1959 are given. The bi-hourly data from all available neutron-monitor stations are used for a special study of the recovery phase. The results are discussed and compared to some existing theories of the modulation mechanism of a Forbush decrease. A cosmic-ray decrease displaying a case of enhanced daily variation in January 1959 is studied. The results are compared to a theory of a co-rotating region of enhanced solar wind. (M.O.W.)

36546 COSMIC RAYS. Rosen, Stephen. Atomes (Paris), 24: 72-8(Feb. 1969). (In French).

The identification of cosmic rays as partially or completely ionized atoms brings their genesis into question. The source of their energy and how their distribution of atomic numbers differs from that of stars raise more questions. The nuclear distribution may be explained by spallation processes. To get the correct distribution of energies, one must divide the flux of cosmic rays into several components; conceivably this reflects on the source of the particles. The isotropy of radiation at the surface of the earth and the constancy of flux with time suggest models for the source. The mechanism for emission at the source is discussed; the energy required is calculated. Models suggesting interaction of cosmic rays with interstellar matter are noted. Motion of the particle through space is suggested not to be linear but to deviate from linearity by reason of passing through magnetic fields in space; other results of interaction, such as formation of other particles or spallation, are outlined. (BBB).

36547 UNIVERSAL COSMIC RAYS AND HARRISON'S INHOMOGENEITY POSTULATE. Noerdlinger, Peter D. (Univ. of Iowa, Iowa City). Phys. Rev., 181: 2143(May 25, 1969).

Cosmologies of the type suggested by Harrison, in which initial baryon inhomogeneity leads to the formation of galaxies, are shown to preclude the possibility that the bulk of cosmic rays are universal. (auth)

36548 UNIVERSAL COSMIC RAYS AND THE MATTER–ANTIMATTER UNIVERSE. Harrison, E. R. (Univ. of Massachusetts, Amherst). Phys. Rev., 181: 2144(May 25, 1969).

The conflict between the universal theory of cosmic rays and the matter-antimatter theory of the universe, discussed by Noerdlinger, can be resolved by looking for antiparticles in the high-energy end of the cosmic-ray spectrum. (auth)

36549 SOLAR PROTON MONITORING. Kohl, J. W. APL (Appl. Phys. Lab.) Tech. Dig., 8: 2-9(Sept.-Oct. 1968).

The Solar Proton Monitoring Experiment (SPME) is intended to provide continuous long-term monitoring of the energetic protons emitted by the sun. Such studies will increase knowledge of the fundamental physical processes involved in solar–geophysical phenomena: solar acceleration processes, interactions in the interplanetary medium, interplanetary magnetic configurations, and interactions with the earth's magnetic field. Such a program has uses, such as its ability to serve as a warning system of radiation hazards. Since the quiet time data in all SPME detectors is essentially galactic cosmic ray background, analysis over a large portion of a solar cycle would give information towards understanding the solar modulation of galactic cosmic rays, including any energy dependence. As particle detectors extend their searches into the lower energy regions, the SPME lower energy detectors indicate that there usually exists a highly variable flux, well above background. The higher energy particles usually remain at the level of cosmic ray background with discrete increases and decay only during times of solar flare activity. Preliminary correlations of particle data with magnetic field information seem to indicate a high degree of isotropy almost always except during solar flare events, although the magnetic field directions change greatly. When near-earth particle data are used in these correlations, an understanding of particle interaction with the earth's magnetosphere is sought. One might determine how solar particles of different energies enter the earth's magnetosphere. Then one might determine a mathematical model for this interaction with the magnetosphere and the trajectories of the particles after entry. (BBB)

Direct Energy Conversion

Refer also to abstracts 36196 and 36565.

36550 (AD–686668) THE EFFECT OF SIMULATED FISSION PRODUCTS IN THE INTER-ELECTRODE SPACING OF A THERMIONIC DIODE. Annual Report No. 4, November 1, 1967–October 31, 1968. Davis, Monte V. (Arizona Univ., Tucson. Engineering Experiment Station). Oct. 1968. Contract Nonr-2173(13). 27p. CFSTI.

The development of experimental diode systems is discussed. Description of requirements and problems associated with dual vapor (barium and cesium) at temperatures greater than 750°C are presented. The density of ions trapped in the double emitter sheath is calculated analytically; and the results displayed. A numerical calculation of the effect of an array of point dipoles on a surface work function is compared with an analytical result using smeared charge sheet potentials. (auth) (USGRDR)

36551 (JUL–580–TP) APPLIED MAGNETOHYDRODYNAMICS. NO. 4. RESULTS OF MEASUREMENTS AND PRACTICAL EXPERIENCE WITH THE MHD EXPERIMENTAL INSTALLATION ARGAS I. Bohn, T.; Grawatsch, K.; Holzapfel, Ch.; Kolb, G.; Komarek, P.; Lang, H.; Noack, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Technische Physik). Mar. 1969. 60p. (In German). Dep.

The experimental results obtained with the Argas I are described and discussed in detail. The measured characteristics of the individual construction elements (compressor, heater, etc.) established that the values set in the construction would be verified. The cesium recovery installation was the single construction element not operating satisfactorily. All materials used such as the refractory metals (Ta, Mo), the high-temperature steel (Incoloy 800) and the aluminum oxide used for channel insulation performed outstandingly. These technical results appear of great value for model studies of larger MHD power projects. The MHD measurements carried out with the present channel can be characterized as follows: (1) the measured value of the Faraday no-load voltage attained the theoretical value only for $\beta \leq 1.7$, always being smaller for larger β values; (2) the effect of the nonequilibrium ionization with the correlated conductivity increase could be clearly detected; (3) the Hall voltage and the effective Hall parameter were always smaller than the corresponding theoretical values; (4) fluctuations caused by plasma instabilities were measurable for $\beta > 1.7$; and (5) the measurements show that the insulation of the diffuser was not sufficient and yielded considerable internal current to ground. The installation was shut down for a period for the installation of a longer channel with a large superconducting magnet. (tr-auth)

36552 (N–69–23384) RESEARCH IN THERMIONIC CONVERSION. Final Report, September 1966–September 1967. Lieb, D.; (and others) (Thermo Electron Corp., Waltham, Mass.). Sept. 1967. Contract NAS7-508. 248p. (NAS-CR-100658; TE–4072-49-68). CFSTI.

The results of a detailed theoretical analysis of the plasma properties of thermionic converters are presented, with particular emphasis on the influence of electron thermal conductivity and ionization rate on spatial distributions. Parametric data obtained from variable spacing converters, including those with electro-etched rhenium emitters and with single crystal tungsten emitters, are given. The effect of oxygen on converter performance, studied in a variable spacing research converter, is discussed, along with data on the possibility of using cesium oxides as a source of both cesium and oxygen. The behavior of MoO_3 as an oxygen additive is investigated, with results indicating that it does release oxygen although not in the amounts expected. Studies on the use of electropositive additives to improve the performance of low-pressure cesium converters indicate that the emitter work function is reduced, but that improvement in converter performance is doubtful. (STAR)

36553 A 25,000-kW PILOT MHD POWER PLANT. Kirillin, V. A.; Neporozhnii, P. S.; Scheindlin, A. E. (Inst. for High Temperatures, Moscow). Energy Convers., 9: 41-6(June 1969).

A 25,000-kW pilot MHD power plant under construction is described. The selection of scale and scheme is substantiated for the Y-25 plant, which is to provide efficient electrical output for long duration reliable operation. The thermal scheme chosen includes all the components characteristic of large scale open-cycle MHD steam power plant. A distinguishing feature of the thermal scheme is natural gas used as fuel, and oxygen-enriched air preheated up to 1200°C as oxidant. The ionizing seed is K_2CO_3. The oxidant preheat is performed in separately fired regenerative air heaters. The Y-25 MHD generator is of a linear conduction type, rated to produce an output of 25,000 kW. At the first stage magnet system iron core is used, which provides field intensity of 2T. A detailed description is given of the major Y-25 components including the combustion chamber MHD generator, high-temperature air heater, steam generator, seed-injection and recovery systems. (auth) (UK)

36554 PROCEDURE FOR THE SIMULTANEOUS DETERMINATION OF THERMOELECTRIC PROPERTIES. Richards, J. D. (3M Co., St. Paul). Energy Convers., 9: 73-82(June 1969).

A new method is described for determining the thermoelectric properties of a material (i.e., the Seebeck coefficient, thermal conductivity, and the electrical resistivity) on individual test specimens as functions of temperature up to 1300°F. Measurements are made, at quasi-thermal equilibrium conditions, of the Seebeck voltage, E_s, conducted heat flux, Q_c, and resistance R, over a wide range of temperature gradients. The data reduction scheme consists essentially of using multiple regression techniques to express E_s, Q_c, and R. Q_c as polynomial functions of various powers of the hot and cold junction temperatures. The partial derivative with respect to the hot and cold junction temperatures of these three expressions yields the Seebeck coefficient, thermal conductivity, and the product of thermal conductivity and resistivity, respectively. (auth) (UK)

36555 TWO-PHASE CYCLES OF MHD CONVERSION USING LIQUID METALS. Pericart, J. (Electricite de France, Paris). Rev. Inst. Fr. Petrole Ann. Combust. Liquides, 22: 313-55(1967). (In French).

Two-phase liquid-metal cycles that allow direct conversion of heat into electricity in an MHD converter by operating at lower temperatures than in plasma cycles are reviewed. A critical analysis and evaluation of the current status of this problem as it is being studied in various large industrial research laboratories in Europe and the United States are made. The basic theory by which a liquid metal is put in motion by direct contact with hot gas expansion is discussed. The numerous two-phase systems proposed thus far are classified. The thermodynamic aspects of the problem are mentioned, followed by a theoretical and experimental examination of the different elements making up two-phase cycles and, in particular, the liquid-metal MHD generator. Future prospects, which include power plants on board spacecraft as well as further steps in the conception of large terrestrial power plants, are discussed. Progress being made in individual MHD laboratories is outlined. 60 references. (BBB)

36556 MHD-ENERGY CONVERSION: RESULTS AND OBJECTIVES OF GERMAN RESEARCH. Lengyel, L. L. (Institut fuer Plasmaphysik, Garching, Ger.). Atomwirt., Atomtech., 14: 243-6(May 1969). (In German).

The principal German research on MHD conversion is described for three types of MHD converters. MHD generators operating with rare gas–alkali metal mixtures, generators with liquid metal as the working medium, and generators fed with fossil or chemical fuels are discussed. (J.S.R.)

36557 EXPLOSIVE, MAGNETOHYDRODYNAMIC (MHD) GENERATOR WITH A SUPERCONDUCTING MAGNETIC SYSTEM. Kirillin, V. A.; Al'tov, V. A.: Asinovskii, E. I.; (and others) (Inst. of High Temperatures, Moscow. Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR, 185: 316-19(Mar. 11, 1969). (In Russian).

The MHD-generator was an explosive shock tube coupled with a superconducting magnetic system. A total of 15 g of explosive material was placed in a cylindrical chamber having a volume of 0.3 l. Thus 87 kilojoules of energy was concentrated in the chamber which was connected with a rectangular-shaped channel 49 × 17 × 590 mm. The whole unit was made of stainless steel. A dampening capacity with a volume of 17 liters was used to remove explosive products and to reduce the noise level. The shock-wave velocity, structure, and thickness of the heated gas (argon at 10^{-1} mm Hg std) were investigated by photography at two slits in the channel wall. The electrical conductivity of the plasma was determined from the volt–ampere characteristics. The current distribution in the heated gas vapor was investigated by means of Rogowski loops. The average velocity of the vapor lock was 8.3 km/sec, and its thickness was 3.0 cm. The effective electrical conductivity was 18 mho/cm. The distribution of current in the plasma was homogeneous. The displacement of magnetic field did not exceed 300 oersteds, which corresponds to a magnetic Reynolds number of about 0.1. Total energy of the vapor lock was 420 Joules. The mechanical work of the plasma was 40 Joules, and the Joule losses were 20 Joules. The total efficiency of converting plasma energy to electrical energy was 4.8%. The possibility of operating an explosive, MHD generator was established. (TTT)

36558 ELECTRICALLY INSULATING WALL FOR MHD CONVERSION DUCTS. Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,158,525. July 16, 1969. Priority date Mar. 22, 1966, France.

The insulating wall described has high resistance to thermal shock and possesses a high heat-removal capacity, thereby making it possible to maintain a sufficiently low temperature at the frontal face. (M.O.W.)

36559 COMPOSITE ELECTRODE FOR MHD CONVERSION DUCT. Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,158,526. July 16, 1969. Priority date Mar. 22, 1966, France.

The electrode comprises a casing of thermally conductive material kept at low temperature and a partition structure provided on one face to define cells in which blocks of ceramic material are positioned. The blocks are connected to the casing by metallic elements, ensuring the passage of electric current from the front face of the electrode to the casing. (M.O.W.)

36560 A SUPERCRITICAL THERMODYNAMIC POWER CYCLE WITH MHD GENERATOR. Braun, J.; Roberts, A. S. Jr. (Aktiebolaget Atomenergi, Studsvik, Sweden). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 771-3(Apr. 1969).

The thermodynamic parameters of a MHD cycle employing supercritical mercury are investigated. A comparison is made with the supercritical turbine generator system suggested earlier. (M.O.W.)

36561 ELECTRON DENSITIES AND TEMPERATURES IN A CLOSE-SPACED CESIUM PLASMA DIODE. Reichelt, W. H. (Los Alamos Scientific Lab., N. Mex.). Appl. Phys. Lett., 14: 382-4(June 15, 1969).

Spectrographic techniques have been used to determine electron temperatures and densities in the interelectrode plasma of a close-spaced high-current cesium plasma diode. These results were obtained from the relative intensity of the radiative recombination continuum and measured linewidths, respectively, of cesium. The diode was operated at two short-circuit current conditions (~15 and 18 A/cm²) with an interelectrode spacing of 0.25 mm. Contrary to some theories, these results indicate that steep temperature gradients do exist in the plasma and that maximum electron temperatures are 2800°K. (auth)

Fluid Physics

36562 ASYMPTOTIC STABILITY IN MHD. Rionero, Salvatore. Ann. Mat. Pura Appl., 76: No. 4, 75-92(1967). (In Italian).

The motion in a bounded region S of space having the frontier Σ is dealt with when the velocity v and the magnetic field H are to satisfy the conditions $v(P,t) = v_1(P,t)$, $H(P,t) = H_1(P,t)$, $P \in \Sigma$, for every $t \geq 0$, $v(P,0) = v_0(P)$, $H(P,0) = H(P)$, $P \in S$, $t = 0$. Assuming the existence of the integrals of the magnetohydrodynamic equations, sufficient conditions are looked for of asymptotic stability on the average, i.e., if (v, H, p) denotes a solution of the equations and (v + u, H + h, p + p) another solution, the problem is to find conditions ensuring that from u = 0, h = 0 when $P \in \Sigma$, for every $t \geq 0$, it follows that $\lim_{t\to\infty} \int_S (au^2 + bh^2)\, dS = \lim_{t\to\infty} \int_S u^2\, dS = \lim_{t\to\infty} \int_S h^2\, dS = 0$, with a and b positive constants. It is deduced that the derivative D of the sum of the kinetic and magnetic energies of the motion described by u and h; then some inequalities are recalled and upper bounds are established for D. From these results a condition is derived concerning the Reynolds numbers and the Hartmann number, and a condition concerning the Reynolds numbers, the magnetic pressure and the current density. The results generalize the conditions found by J. Serrin [Arch. Rational Mech. Anal., 3: (1959), 1–13; MR 21: 3993]. (Math. Rev.)

36563 EXPERIMENTAL STUDY OF THE FREE SURFACE BELOW A HEADER VALVE IN MAGNETOHYDRODYNAMIC FLOW. Causse, Rene; Chambarel, Andre (College Scientifique Univ., Vaucluse, France). Compt. Rend., Ser. A, 268: 910-12(Apr. 21, 1969). (In French).

An experimental study was made of the free surface of flow in a rectangular horizontal tube of an electroconducting liquid (mercury) in the presence of a magnetic induction field vertical, then horizontal. (tr-auth)

36564 HYDROMAGNETIC STABILITY OF SPIRAL FLOWS. Agrawal, G. S. (Indian Inst. of Tech., Kanpur). J. Phys. Soc. Jap., 26: 1519-25(June 1969).

Effects of an axial magnetic field and axial currents on the stability of spiral flows of a nondissipative system are investigated. A sufficient condition of stability is obtained when all the four components, namely, the swirl velocity, axial velocity, axial magnetic field, and axial currents are present. In particular, the case when the axial velocity is not present is discussed in detail, and it is shown that the sufficient condition for stability obtained by Howard and Gupta is valid only for oscillatory modes; further, the necessary condition for the existence of nonoscillatory neutral modes is obtained. (auth)

36565 POTENTIAL OF ELECTROGASDYNAMICS (EGD) FOR BULK POWER GENERATION. Bhada, R. K.; Schulze, K. H.; Boll, R. H. (Babcock and Wilcox Co., Alliance, Ohio). Energy Convers., 9: 47-53(June 1969).

The electrogasdynamic generator directly converts heat to electricity by transferring charge from low potential to high potential. It is functionally similar to a turbine-dynamo, but can produce high-voltage (500,000 to 1,000,000 volts) power with no moving parts or magnets. An evaluation of the use of fossil-fuel fired EGD generators for bulk power is presented. The study is limited to the slender-channel (low radius/length) type of generator, which is claimed to be able to produce high power density and to give good efficiency. A mathematical evaluation of the theoretical maximum performance that could be obtained is made, taking into account all pertinent factors such as ion slip, frictional losses, and electrical leakage. The mathematical analysis indicates that, among other problems, in order to obtain practical performance, it is necessary that the resistivity of the channel wall be about $5 \times 10^7\ \Omega$ at 1500 to 2000°F. A theoretical and experimental search failed to reveal any commercially available material compatible with combustion gas which possessed the high resistivity in this temperature range. It is concluded that the application of slender-channel EGD for bulk power generation appears very unattractive. (auth) (UK)

36566 ELECTROHYDRODYNAMIC FLOW OVER A WAVY WALL. Kuwabara, Sinzi (Cornell Univ., Ithaca, N. Y.). J. Phys. Soc. Jap., 26: 1525-40(June 1969).

Electrohydrodynamic flow over an insulator wavy wall is studied by the perturbation method similar to the Prandtl–Glauert method. The charged gas is assumed to be a simple one and not to have dissipative effects. For the subsonic flow, a modified M^2-expansion method is applied, because the straightforward M^2-expansion method gives a wrong asymptotic behavior. The surface pressure, the streamlines, and the electric lines of force are calculated. (auth)

36567 ELECTROHYDRODYNAMIC OSCILLATING PISTON PROBLEM. Kuwabara, Sinzi (Cornell Univ., Ithaca, N. Y.). J. Phys. Soc. Jap., 26: 1540-5(June 1969).

The linearization method of Prandtl–Glauert type is applied to the electrohydrodynamic supersonic flow over a wavy wall. But it is found that it has no solutions satisfying the appropriate boundary conditions. Thus, a simplified model of an oscillating piston problem for this flow is considered. Numerical solutions of this problem are obtained as the initial-value problem. The density distributions and the streamlines are calculated. It is found that sufficiently far from the piston, shocks are fully developed. (auth)

36568 HYDROMAGNETIC STABILITY OF HETEROGENEOUS SHEAR FLOW. Agrawal, S. C.; Agrawal, G. S. (Indian Inst. of Tech., Kanpur). J. Phys. Soc. Jap., 27: 218-23(July 1969).

The stability of nondissipative, heterogeneous shear flow in the presence of a uniform magnetic field applied in the streaming direction was investigated. The main results established are: (i) the waves propagating along the streaming direction are the most unstable ones and, hence, the two-dimensional analysis is made throughout; (ii) the complex wave velocity of an arbitrary unstable mode must lie within a semicircle in the upper half plane whose radius is less than the radius of Howard's semicircle; and (iii) if the magnetic force number exceeds a certain quantity, which depends only upon the streaming velocity, the system is completely stabilized. Further, the case when the applied magnetic field is weak is analyzed. (auth)

36569 APPLICATION OF THE LAPLACE TRANSFORM TO THE SOLUTION OF THE BOUNDARY LAYER EQUATIONS. III. MAGNETOHYDRODYNAMIC FALKNER–SKAN PROBLEM. Apelblat, A. (Israel Atomic Energy Commission, Neger, Israel). J. Phys. Soc. Jap., 27: 235-9(July 1969).

Boundary-layer equations for the magnetohydrodynamic version of the Falkner–Skan problem are solved with the use of the Laplace transform and the steepest descent technique. For the boundary-layer flow of an electrically conducting fluid past a semi-infinite flat plate, the viscous stress at the plate disappears when the adverse magnetodynamic pressure gradient is close to $1/11\ U_\infty^2(1-S)x^{-1/11}$. The quantity S gives the ratio of the magnetic to kinetic energy and U_∞ is the uniform velocity at the main flow. The possibility to extend the Laplace transform method to the evaluation of infinite integrals connected with the boundary condition at infinity is also demonstrated. (auth)

36570 NORMAL MODES OF DECAY OF A MAGNETIC FIELD IN MAGNETOHYDRODYNAMICS. Jady, R. J. (Univ. of Exeter, Eng.). Quart. J. Mech. Appl. Math., 22: 65-74(Feb. 1969).

The effect of nonuniform rotation, in which the angular velocity is an increasing function of the distance from the axis in an infinite circular conducting fluid cylinder, on the normal modes of decay of a magnetic field are studied. It is found that the field is carried round by the fluid. For slow motion, the field in each mode rotates with an angular velocity proportional to the fluid velocity, in the fast decaying modes the angular velocity of the field being one third the angular velocity of the fluid at the boundary. For fast motion, the field in the low modes rotates with the angular velocity of the fluid either near the axis of the cylinder or near the boundary. Apart from the field in the fundamental mode the shearing motion can increase the time of decay, though in no case is there a substantial increase. (auth) (UK)

36571 ELECTROHYDRODYNAMIC CONVECTION. Roberts, P. H. (Univ. of Newcastle-upon-Tyne, Eng.). Quart. J. Mech. Appl. Math., 22: 211-20(May 1969).

Experiments were performed by Gross in which a layer of insulating oil was confined between horizontal conducting planes, spaced at a distance d, and heated from above and cooled from below. When a vertical electric field E of sufficient strength was applied across the layer, a tessellated pattern of motions was observed which, despite the fact that buoyancy was stabilizing, was strikingly similar to that characteristic of Bénard convection. These motions cannot be explained by the "free surface" and "interfacial" effects investigated by Malkus and Veronis since the layer was homogeneous in composition and in contact with rigid boundaries at its surfaces. Gross suggested that the motions might be set up via the variation of dielectric constant ϵ of the fluid with temperature. This mechanism is described and its governing equations are derived. An approximation analogous to the Boussinesq approximation of Bénard convection is developed. It is shown that the behavior of the system is decided by the values of two nondimensional parameters; $P = \nu/\kappa$, the Prandtl number (where ν is kinematic viscosity and κ is thermal diffusivity), and L, a parameter analogous to the Rayleigh number R of Bénard convection and defined by $L = (V\xi)^2/4\pi^2\rho\nu\kappa$, where V is the potential difference between the planes, ξ the difference in ϵ in the fluid in contact with them, and ρ is the density. It is shown that if L exceeds a critical value, L_c, of 2129, independent of P, the layer is indeed convectionally unstable to motions whose horizontal semi-wavelength is 0.974 times the depth of the layer. The values of L attained by Gross in his experiments appear, however, to be only about $10^{-7}\ L_c$. An alternative possibility, that the convection is due to free charge conducted into the layer, is examined briefly, and is also found wanting. (auth) (UK)

36572 SLOW MOTION OF BODIES IN STRATIFIED AND ROTATING FLUIDS. Graebel, W. P. (Univ. of Michigan, Ann Arbor). Quart. J. Mech. Appl. Math., 22: 39-54(Feb. 1969).

The flow due to a body moving horizontally in a fluid with moderate vertical density gradient is found in the limit of small Reynolds number and zero diffusivity using the technique of matched asymptotic expansion theory. The solution yields an upstream wake-like behavior, a thin layer on the rear of the object somewhat analogous to an Ekman layer, and small equatorial regions. There is no wake in this limit downstream of the body. The flow due to a body moved slowly along the axis of a fluid in strong rotation is also considered. The behavior is similar upstream and downstream of the body due to the symmetry of the equations and the difference in the mechanism of propagation of the body force. A general solution is presented for ranges of the parameters analogous to the stratified case, and some general conclusions are drawn concerning the rotation of the body when allowed to move without torsional restraint. When a body is moved slowly along the axis of a rotating fluid, the results of Taylor (1917) and Proudman (1916) suggest, on the basis of linearized inviscid theory, that the body will carry along with it the fluid inside a cylinder circumscribing the body and having its generators parallel to the axis of rotation. YiH (1959), using a model with analogous linearization, obtained similar results for flow with strong density stratification, indicating that a body moved horizontally should carry along the fluid between horizontal planes tangent to and containing the body. Similar effects have been observed in magnetohydrodynamic flows. These theories leave much to be desired in describing the flow, since the solutions have a high degree of arbitrariness. For the cases of rotation and magnetohydrodynamic flows, this arbitrariness was resolved by consideration of the initial-value problem (Stewartson (1953)) or inertia (Ludford (1900)). In the present work the author investigated how the consideration of viscous effects also eliminates this arbitrariness for the stratified and rotating cases. (auth) (UK)

36573 INCOMPRESSIBLE MAGNETOHYDRODYNAMIC ENTRANCE FLOW IN A PLANE CHANNEL. Saric, William S.; Touryan, Kenell J. (Sandia Lab., Albuquerque, N. Mex.). Phys. Fluids, 12: 1412-19(July 1969).

The hydromagnetic flow of a conducting, incompressible fluid in

the entrance section of a plane channel is analyzed. The problem is generalized to include a small cross-flow, small wall injection, Hall currents, and ion slip. The solution is carried out using two methods. The first is the generalized Kármán–Pohlhausen momentum integral method, and the second utilizes asymptotic power series in the small parameter $\xi = [(x/L)/(Re)]^{\frac{1}{2}}$. The equations are solved numerically, and the two results compared with one another, as well as with similar studies in the literature. (auth)

36574 INVARIANT TRANSFORMATIONS IN NON-STEADY GASDYNAMICS AND MAGNETO-GASDYNAMICS. Rogers, Colin (Univ. of Nottingham, Eng.). Z. Angew. Math. Phys., 20: 370-82(May 25, 1969).

A general formulation of invariant transformations based on a matrix description of the governing equations is introduced. It is seen how invariant transformations may be generated by specialization of the matrices involved, and examples of such mappings are presented. (M.O.W.)

36575 MAGNETOGASDYNAMIC FLOWS IN TWO DIMENSIONS WITH ORTHOGONAL MAGNETIC AND VELOCITY FIELD DISTRIBUTIONS. Power, Geoffrey; Talbot, Richard F. (Univ. of Nottingham, Eng.). Z. Angew. Math. Phys., 20: 358-69 (May 25, 1969).

Certain properties are established for the two-dimensional, steady, magnetogasdynamic flows of inviscid, thermally nonconducting fluids having infinite electrical conductivity when the magnetic intensity and velocity fields are everywhere orthogonal. It is also shown that for such flows as these, one may reduce the MGD flows to planar gasdynamic flows with zero magnetic field, provided that one additional condition is satisfied. An intrinsic formulation was used. A number of illustrations are given exploiting the technique and showing how a simple MGD flow problem may be solved by means of the transformations obtained. (M.O.W.)

36576 NONIDEAL MAGNETOGASDYNAMIC FLOWS IN BOUNDARY-LAYER APPROXIMATION. Friedel, Helmut (Innsbruck Univ.). Z. Angew. Math. Phys., 20: 329-42(May 25, 1969).

Starting from a magnetic boundary-layer approximation, slowly diverging and converging compressible MGD flows have been investigated. This magnetic boundary layer characterized by negligible ordinary viscosity and weak but dominant magnetic viscosity is determined by the strong coupling between the magnetic field and the flow field. In general, this coupling somewhat complicates the boundary layer equations such that their analytic solution can only be realized by means of a similarity transformation. Only the limiting case $R_{M\delta} \to \infty$ allows a general analytic solution to be obtained. By using certain symmetry conditions the solutions have been restricted to symmetric internal (channel- or jet-) flows. Also, external flows (over slender bodies) can be treated in a quite analogous manner, starting from corresponding symmetry conditions. It is shown that even finite electric conductivity may cause free turbulence of certain jet configurations. Of course, this fact does not say anything about general turbulent behavior of such a jet but it opens a large field of interesting questions concerning finite resistivity turbulence within magnetic boundary layer theory. (auth)

36577 FLOW-TRANSITION THROUGH SEVERAL OBLIQUE HYDROMAGNETIC SHOCKS. Upadhyaya, K. S. (Univ. of Allahabad, India). Tensor, 19: 337-40(Sept. 1968).

Warsi (Tensor, 15: 142-4(1964)) discussed the flow transition through $m-1$ successive shock waves in an ideal nonconducting fluid. He later extended the results to magnetogasdynamic shock waves (Tensor, 16: 187-92(1965)). Some objections to the technique adopted in the latter reference are discussed in this note. (TSS)

36578 UNSTEADY ROTATIONAL FLOW BEHIND A HYDROMAGNETIC SHOCK WAVE. Ram, Rishi (Univ. of Allahabad, India). Tensor, 19: 255-64(Sept. 1968).

The condition for existence and uniqueness of flows behind an unsteady magnetogasdynamic shock wave has been obtained and the gradients of flow variables and the curvature and torsion of streamlines have been effectively determined (Tensor, 18: 323-9(1967)). The object of the present paper is to develop a short and universal method in order to determine higher-order derivatives of flow and field parameters and to obtain expressions for the curvature and torsion of vortex lines generated behind shock waves in unsteady flows of conducting gases. (TSS)

36579 THREE CONFLUENT SHOCKS IN FLOWS OF CONDUCTING GASES. Ram, Rishi (Banaras Hindu Univ., India). Tensor, 20: 83-7(Jan. 1969).

The configuration of three shocks through a point was discussed by Courant and Friedrichs (Supersonic Flow and Shock Waves, Interscience Publishers, Inc., New York, 1948) in polytropic and nonconducting gases and it was proved on the basis of the particular form of the equation of state that three shocks separating three zones of different continuous states are impossible. A proof, independent of the form of the equation of state, is presented here for the impossibility of three confluent shocks separating the flow of conducting gases into three different uniform states. This impossibility of the three-shock configuration without a slip stream is due strictly to the dynamical behavior of the fluid and does not depend upon its thermodynamic behavior and, as such, the result is purely kinematical. (auth)

36580 INTRINSIC PROPERTIES OF PSEUDOSTATIONARY MAGNETOGASDYNAMIC FLOWS. Purushotham, G.; Madhusudan (Nagarjunasagar Engineering Coll., Hyderabad, India. Agarwal Evening Science Coll., Hyderabad, India). Tensor, 20: 103-6 (Jan. 1969).

Considering two systems of triply orthogonal spatial curves of congruences, one related to the streak lines and other to the magnetic lines of force, and their principal normals and binormals, intrinsic properties of pseudostationary magnetogasdynamic flows are studied. (auth)

Geophysics (Upper Atmosphere)

36581 (AD-683337) STUDY OF IONOSPHERE PROPAGATION AT FREQUENCIES FROM 4 TO 64 MHz. Final Report, March 1964–February 1967. Dueno, Braulio (Puerto Rico Univ., Mayaguez. Coll. of Agriculture and Mechanic Arts). July 1968. Contract AF19(628)-3999. 42p. (AFCRL-68-356). CFSTI.

Techniques for the recording and analysis of phase variations of pulse-modulated ground backscatter data are discussed. It is shown that these techniques are capable of yielding additional information about the characteristics of layers of the ionosphere capable of supporting ground backscatter. The formation and motion of ionospheric irregularities of electron density are easily determined by these techniques. An effort was made to determine whether or not it is possible to detect any difference between land and sea slant backscatter. It was found that at the high frequencies (8 to 64 mHz) used in the experiment the solar control effect on the F2 layer in the directions from 90 degrees to 180 to 270° was very much larger than the possible difference between land and sea backscatter that it rendered impractical the detection of this difference. (auth) (USGRDR)

36582 (AD-684715) A SURVEY OF SOME RECENT RESEARCH ON MAGNETO-PLASMA DIFFUSION AND THE IONOSPHERIC F2 LAYER. Final Report, Part 1, January 1, 1965–June 30, 1968. Ferraro, V. C.; Kendall, P. C. (Sheffield Univ. (England). Queen Mary Coll., London (England)). Jan. 1, 1969. 58p. (AFCRL-69-106). CFSTI.

Recent work on magnetoplasma diffusion carried out at Queen Mary College, University of London, and the University of Sheffield is reviewed, including reference to some other current work on meteor trains, the general problem of magnetoplasma diffusion, and the problem of diffusion in the ionospheric F2 layer. (auth) (USGRDR)

36583 (N-69-23557) COMPUTATION OF TOPSIDE IONOGRAMS FROM N(h) PROFILES. Colin, Lawrence; Chan, Kwok-Long; Lee, Jack G. K. (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). Apr. 1969. 35p. (NASA-TN-D-5052). CFSTI.

Model profiles of plasma frequency and gyrofrequency are chosen to simulate typical conditions observed in the topside ionosphere by the Alouette I sounder (1000 km) and the Alouette II sounder near apogee (3000 km). Examples of group refractive index profiles for these models are presented. By means of parabolic-in-log x lamination techniques applied to the plasma frequency profiles, cumulative delays are computed to illustrate the relative delays contributed by each lamination to the formation of topside ionograms. Complete ionograms (ordinary, extraordinary, and z traces) are presented for all the models. Implications of the results to the inverse experimental problem of scaling ionogram data and computing electron concentration profiles are discussed. (auth) (STAR)

36584 (N-69-24173) ELECTRON DENSITIES IN THE LOWER IONOSPHERE DEDUCED FROM PARTIAL REFLECTION MEASUREMENTS. Its Aeronomy Report No. 29. Pirnat, C. R.; Bowhill, S. A. (Illinois Univ., Urbana. Aeronomy Lab.). Dec. 15, 1968. 77p. (NASA-CR-100757). CFSTI.

The history and underlying theory of the partial reflection experiment is reviewed. An electron density profile is calculated

from differential absorption measurements using a collision-frequency model extrapolated from rocket measurements. This profile is in reasonable accord with rocket measurements of electron density. In reviewing the applicability of a partial reflection experiment using high-frequency radiowave pulses, the main limitation was found to be atmospheric noise. (auth) (STAR)

36585 (N-69-24519) VLF ELECTRIC AND MAGNETIC FIELDS OBSERVED IN THE AURORAL ZONE WITH THE JAVELIN 8.46 SOUNDING ROCKET. Gurnett, Donald A.; Mosier, Stephen R. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Feb. 1969. Contracts NSR-16-001-025; Nonr-1509(06). 44p. (NASA-CR-100769). CFSTI.

Results of the Javelin 8.46 vlf electric and magnetic fields experiment flown from Ft. Churchill, Canada, on May 25, 1968, are discussed. This experiment carried three orthogonal magnetic loop antennas, three orthogonal long (3.16 meters) electric dipoles, two short (42 cm) electric dipoles, and six wideband (30 Hz to 10 kHz) receivers for amplifying signals from the various vlf antennas. Intense noise bursts with frequencies less than about 1.5 kHz were observed on all the electric antennas below 500 km, but not on the loop antennas. The precession and spin modulation of these noise bursts suggest that the noise is generated by an interaction between the payload and the surrounding plasma. High frequency electrostatic noise bursts, from 5 to 30 kHz, were observed throughout the flight. (auth) (STAR)

36586 IONIZATION TROUGHS BELOW THE F2-LAYER MAXIMUM. Bowman, G. G. (AVCO Corp., Lowell, Mass.). Planet. Space Sci., 17: 777-96(May 1969).

Direction-of-arrival information is available on ionograms from Ellsworth, Antarctica, because of interference effects from the Filchner Ice Shelf. This has allowed the detection of extremely large ionospheric disturbances which appear to move towards the equator with speeds of the order of 100 m/sec, in the late afternoon and early evening hours. These disturbances produce troughs in the bottomside ionosphere having widths as large as 1000 km, the electron density at the maximum of the F2 layer being reduced by an order of magnitude. Disturbance effects are also recorded in the D and E layers. Associations with radio auroras and magnetic activity have been found. It is suggested that the troughs mark the positions of red-auroral arcs. The apparent movement of the trough as observed at Ellsworth has been explained in terms of the rotation of the Earth, the trough position being imagined as stationary with respect to the Sun. It seems likely that topside troughs are the upper F2-region extensions of bottomside troughs and that these can be identified (along the Earth's magnetic field lines) with the plasma-pause, at least in the night hours after midnight. The troughs seem to define the boundary between the quiet and active regions of high latitudes. It is suggested that this boundary moves closer to the equator when the solar wind speed increases. (auth) (UK)

36587 HYDROXYL EMISSION OF THE UPPER ATMOSPHERE. I. THE BEHAVIOUR DURING A SOLAR CYCLE, SEASONS, AND GEOMAGNETIC DISTURBANCES. Shefov, N. N. (Inst. of Physics of the Atmosphere, Moscow). Planet. Space Sci., 17: 797-813(May 1969).

Average seasonal variations of the intensity and the rotational temperature of the hydroxyl emission at different latitudes were derived from observational data obtained over many years at Zvenigorod and other stations. The solar cycle variations of the OH emission are also given. Influence of geomagnetic disturbances of various intensities on the intensity and rotational temperature of OH emission has been detected. Periodic variations in the intensity and rotational temperature appear a few days after the commencement of a geomagnetic storm and last for up to 30 days. The delay in time depends on the latitude, and in the vicinity of the equator is about 10 days. Disturbances seem to spread from the auroral zone with the meridional velocity component of 5 to 10 m/sec. The additional energy of the hydroxyl emission, as a result of a geomagnetic storm, is released mainly at latitudes of over 30°. The planetary energy during a storm is maximum for disturbances with $a_p \approx 140$, and reaches in this case 4×10^{23} erg. (auth) (UK)

36588 THE INFLUENCE OF VARYING SOLAR FLUX ON IONOSPHERIC TEMPERATURES AND DENSITIES: A THEORETICAL STUDY. Herman, J. R.; Chandra, S. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 17: 815-40(May 1969).

The electron continuity equation and the heat conduction equations for electrons, ions, and neutral species are solved simultaneously for specified boundary conditons and values of the solar flux. These solutions yielded a set of self-consistent steady-state profiles for a variety of midday solar conditions that are in agreement with observational data. In order to produce these profiles only the boundary conditions and solar flux are used as variable parameters of the problem. It is shown that the neutral temperature and the resulting neutral gas composition play a dominant role in determining the charged-particle density and temperature profiles. This leads to a picture of the solar-cycle variation where composition changes in the neutral gas (introduced at the lower boundary) must be combined with the solar-flux variation to produce physically reasonable results. Of the five neutral gases used (N_2, O_2, O, He, H), the atomic oxygen density variations are shown to be most effective in producing the observed trends for all the temperatures and densities in the E and F regions. (auth) (UK)

36589 THERMAL DIFFUSION IN THE TOPSIDE IONOSPHERE FOR MIXTURES WHICH INCLUDE MULTIPLY CHARGED IONS. Schunk, Robert; Walker, James C. G. (Yale Univ., New Haven). Planet. Space Sci., 17: 853-68(May 1969).

Thermal diffusion coefficients were evaluated for a fully ionized plasma containing a mixture of ions of arbitrary charge in which two ions may have densities comparable to the electron density. In order to illustrate the ionospheric effects of thermal diffusion diffusive equilibrium density profiles in the topside ionosphere were calculated for O^+, H^+, N^+, He^+, O^{2+}, and N^{2+} ions. The influence of thermal diffusion on the doubly charged ions is particularly large, increasing their densities by more than two orders of magnitude at 1900 km. (auth) (UK)

36590 RADIO NOISE FROM AURORA. Harang, L. (Norwegian Defence Research Establishment, Kjeller). Planet. Space Sci., 17: 869-77(May 1969).

Bursts of radio-wave emissions at 28 Mc recorded by riometers were observed in a few cases to appear at the onset of a sharp and strong absorption dip at nighttime and close to the auroral zone (Tromsø). The emissions consist of series of spikes, and appear during the SC-like phase of a geomagnetic storm and during the breakup phase of an auroral display; the intensity is 1 to 2 dB above the galactic noise level. In most cases, the 28-Mc emissions were accompanied by simultaneous noise emissions in the 8 kc band. It is suggested that the 28 Mc emissions must be generated in the ionosphere, possibly from short-lived plasma oscillations in columns of ionizations produced by the sharp front of the ionizing stream of particles. (auth) (UK)

36591 SOME OBSERVATIONS OF THE PREDAWN ENHANCEMENT OF THE RED LINE AIRGLOW OVER GREAT BRITAIN. Smith, R. W. (Univ. of Exeter, Eng.). Planet. Space Sci., 17: 879-88(May 1969).

Zenith and azimuthal photometric observations of the red line of atomic oxygen predawn enhancement are presented which were made in the years 1965–1968 at Sidmouth, Devon and Earlyburn, Peebleshire, both in the U.K. The measurements indicate that the enhancement is a regular occurrence, at least up to geomagnetic latitude 59.5°N, in the manner reported from lower latitudes. The onset time shows a solar cycle, seasonal, and irregular variation. Evidence is presented to suggest that the long-period variations are related to thermopause temperature and the solar euv intensity. Heights of emission are deduced from the azimuthal measurements, which were mostly in the region 250 to 300 km, and there is a trend towards increasing height with increasing thermopause temperature. (auth) (UK)

36592 AN ASSESSMENT OF THE CONTRIBUTIONS OF VARIOUS TIDAL WINDS TO THE S_q CURRENT SYSTEM. Stening, R. J. (Univ. of Queensland, Brisbane). Planet. Space Sci., 17: 889-908(May 1969).

Methods presented in a previous paper are used to estimate the effectiveness of various wind systems in producing electric currents in the ionosphere. The likelihood of these winds being present in the dynamo region is discussed. A series of calculations of current patterns generated by various wind systems is made using the equivalent-circuit method (Stening, 1968) and a combination of these systems is sought that will produce a current pattern like that observed. It seems that a mixture of positive and negative tidal modes is required. Seasonal changes in the current systems cannot be explained merely by variations in the conductivities but also require changes in the intensities or positions of the wind systems. (auth) (UK)

36593 GEOMAGNETIC DISTURBANCE AND THE TROPOSPHERE. Beynon, W. J. G.; Winstanley, E. H. (University Coll. of Wales, Aberystwyth). Nature (London), 222: 1262-3 (June 28, 1969).

It has been suggested that perturbations in the troposphere may produce significant effects at ionospheric levels, and consideration of the overall energy involved indicates that such a process is more likely than coupling downwards from above; this process has also been demonstrated for waves generated in the lower atmosphere from nuclear explosions. The authors describe some

further experimental evidence bearing on this matter; evidence was obtained for a correlation between disturbances in the troposphere and in the magnetic field. Searches were made for any change in magnetic activity following periods of widespread high ground winds, and for any change in wind speed following large magnetic storms. The main results are summarized, from application of the superposed epoch method. There appeared to be a slight increase in average wind speed two days after a magnetic storm, and for years of high solar activity there appeared to be a decrease in wind speed following a period of magnetic calm. It is concluded from the results that there is some interaction, direct or indirect, between solar and/or magnetic disturbance and the troposphere. (UK)

36594 THE LUNAR VARIATIONS IN THE F2 REGION OF THE IONOSPHERE AT LOW LATITUDES. Dunford, E.; Lawden, M. D. (Radio and Space Research Station, Slough, Eng.). Planet. Space Sci., 17: 923-31(May 1969).

The suggestion by Martyn (1947 and 1955) that the lunar tidal variations of the electron concentration in the F region near the magnetic equator are due to the superposition of a small (lunar) vertical velocity on a large (solar) velocity is extended to examine the lunar variations in the F2 region over the range of latitudes within 25° of the magnetic equator. Because the form of the equatorial anomaly is modified by the lunar component, the lunar variations in electron density show a large latitudinal dependence. The variations of various F-region parameters were calculated assuming equilibrium conditions, and a comparison with experimental data shows that most of the observed features can be explained satisfactorily. (auth) (UK)

36595 BALLOON OBSERVATIONS OF THE TEMPORAL VARIATION OF THE INFRARED ATMOSPHERIC OXYGEN BANDS IN THE AIRGLOW. Evans, W. F. J.; Llewellyn, E. J.; Jones, Vallance (Univ. of Saskatchewan, Saskatoon). Planet. Space Sci., 17: 933-47(May 1969).

The diurnal variation of the (0,0) ($^1\Delta_g - ^3\Sigma_g$) band of O_2 was observed with a filter photometer flown at 30 km on three balloon flights. The photometer is described. No emission originating from below 30 km was detected, and consequently resonance fluorescence cannot play a significant part in the dayglow excitation process. The noon dayglow intensity was 20 MR in October and February, while the nightglow brightness was about 90 kR. Theoretical calculations based on the ozone photolysis theory are described and compared with the observed time variations. During the period when the atmosphere is fully illuminated the observed intensity variations are well reproduced theoretically with a rate constant of about 3×10^{-19} cm^3 sec^{-1} for quenching of $O_2(^1\Delta_g)$ by atmospheric particles and the ozone height distribution taken to be exponential above 40 km. In the evening twilight, for solar depressions greater than 5°, the observed intensity exceeded that calculated by about 500 kR. This discrepancy appears to be related to enhancements in the $O_2(^1\Delta)$ concentrations above 70 km as observed in recent rocket flights. (auth) (UK)

36596 DOPPLER SHIFTS IN THE WAVELENGTH OF THE O I λ6300 LINE IN THE NIGHT AIRGLOW. Armstrong, E. B. (Commonwealth Scientific and Industrial Research Organization, Camden, New South Wales). Planet Space Sci., 17: 957-74(May 1969).

A method of measuring the speeds of neutral winds in the thermosphere by observing Doppler shifts in the wavelength of the O I λ6300 line in the night airglow with a Fabry–Perot interferometer is described, and possible perturbing effects are discussed. The method depends upon the existence of wind streams extending over about 10° in latitude or longitude, and results obtained using it are compared with the neutral wind patterns for altitudes of 250 to 300 km shown by several published theoretical models as well as with other observations. A very broad agreement with the models is evident, but when considered in detail the results indicate that local conditions in the thermosphere may have an influence on winds, and that changes in height of the region emitting the oxygen red line may be responsible for some of the observed effects. Possible correlations of wind variations with h'F changes and apparent O I λ6300 line widths were noted, and these are discussed. (auth) (UK)

36597 WEAK EMISSIONS IN THE NEAR-INFRARED DAYTIME AIRGLOW. Wallace, L.; Broadfoot, A. L. (Kitt Peak National Observatory, Tucson, Ariz.). Planet. Space Sci., 17: 975-84(May 1969).

Rocket-borne spectrometers were used to examine the spectrum of the daytime airglow in the region from 6000 to 11,500 Å. In addition to the previously observed features, a number of fainter emissions were observed. These were the 2–0 band and the 1–0 sequence of the Meinel system of N_2^+ at 7875 and 9212 Å, respectively, the atomic oxygen emissions at 7774 and 8446 Å, and what appeared to be the 1–0 band of the first positive system of N_2 at about 8850 Å. The intensity ratio of the first to second positive systems in the dayglow was estimated and found to be an order of magnitude lower than the auroral ratio. Upper limits on the emission rates of other features not clearly present are also given. (auth) (UK)

36598 NONLINEAR SYMMETRIC INFLATION OF A MAGNETIC DIPOLE. Sozou, C.; Windle, D. W. (Univ. of Sheffield, Eng.). Planet. Space Sci., 17: 999-1008(May 1969).

A self-consistent, time-independent ring current of a particular radiation belt under the influence of the combined field of the Earth's dipole field and the field due to the currents of the particle motions is constructed. The method of solution consists of successive iterations of the magnetic field of the currents due to the particle motions until convergence is obtained. Results are in excellent agreement with the investigations of Baker and Hurley (1967) and Olbert, Siscoe, and Vasyliunas (1968), which predict exactly the magnitude of the disturbance near the Earth's surface corresponding to a given kinetic and magnetic energy of the radiation belt. Solutions for several sets of data were obtained enabling the importance of the effects of the nonlinearity of the model to be inferred. (auth) (UK)

36599 A SIMPLE SECOND-ORDER CORRECTION TO FIRST-ORDER FARADAY ROTATION THEORY IN THE REGION OF QUASI-TRANSVERSE PROPAGATION OF RADIO WAVES THROUGH THE IONOSPHERE. Hudson, R. M. (Univ. of Ibadan, Nigeria). Planet. Space Sci., 17: 1045-50(May 1969).

A simple second-order correction to the first-order Faraday rotation equation was obtained from the Appleton–Hartree equation which depends on the inverse fourth power of the single frequency, and which can be of appreciable size in the region of quasi-transverse propagation through the ionosphere. It is shown that if computations of the total ionospheric electron content are made by using the difference of the angular rotations for two closely spaced frequencies, instead of the total rotation for a single frequency, then the correction term can be eliminated to a good approximation, which is in agreement with experimental observations. (auth) (UK)

36600 NOTE ON AURORAL ELECTRONS. Viswanathan, K. S.; Rajappa, N. (National Aeronautical Lab., Bangalore, India). Planet. Space Sci., 17: 1051-5(May 1969).

It is concluded that auroral electrons are characterized by very low values of the parameter $\underline{m}$, where $\underline{m}$ is the mass of the particle, when compared with the electrons in the Van Allen radiation belts. This result can be tested experimentally. (UK)

36601 NOTE ON THE ANALYSIS OF SCINTILLATION OF SATELLITE SIGNALS. Cappellini, V.; Checcacci, P. F.; de Giorgio, M. T. (CNR, Florence). Planet. Space Sci., 17: 1056-9(May 1969).

Theoretical and experimental studies were undertaken on the amplitude distribution of the signals from satellites when scintillation superimposes on the Faraday effect. An expression for the probability density $p(x)$ of the signal level $\underline{x}$ resulting from Faraday plus scintillation was derived in terms of statistical theory. (UK)

36602 EFFECT OF THE EARTH'S ALBEDO ON THE IONOSPHERIC D LAYER. Gassmann, G. J.; Wagner, R. A. (Air Force Cambridge Research Labs., Bedford, Mass.). Radio Sci., 4: 529-33(June 1969).

An aircraft carrying an ionospheric sounder traversed the boundaries of extended cloud cover near Los Angeles five times on July 18, 1967. Amplitudes of ionospheric E-layer echoes at 3 MHz were received and recorded on magnetic tape, and median values were determined in 1-minute intervals. Although these values scattered over ±3 decibels, the average median was lower, by 2.1 decibels when the aircraft was over cloud cover than when the aircraft was over a cloud-free area. The results suggest that an enhancement of the flux of visible light due to the reflecting cloud cover (estimated albedo 40%) changed the D-layer chemistry in such a way that the electron density increased, resulting in a (6 ± 3)% increase of two-way non-deviative absorption. (auth)

36603 DETERMINATION OF D-REGION ELECTRON DENSITIES FROM MULTIFREQUENCY ABSORPTION MEASUREMENTS. Musser, Jeffrey M. (HRB-Singer, Inc., State College, Pa.). Radio Sci., 4: 521-8(June 1969).

The use of a cubic approximation to the electron density determined by means of multi-frequency absorption measurements does not always yield satisfactory results. An alternate method of determining the electron density is presented. A family of proton spectra is used, and the electron density profile resulting from each spectrum is determined. It is found that each profile produces absorption which varies as f^{-n} with the exponent n characteristic of

the particle profile. These profiles are then varied in magnitude to produce the measured absorption. The result is an electron density profile that gives a more realistic representation of the D region during a proton event than does a cubic approximation. (auth)

36604 LATITUDE VARIATION OF THE LOWER IONOSPHERE. Mechtly, E. A. (Univ. of Illinois, Urbana); Rao, M. Mukunda; Skaperdas, D. O.; Smith, L. G. Radio Sci., 4: 517-20(June 1969).

In March and April, 1965, the University of Illinois and the GCA Corporation launched five Nike–Apache rockets from the aircraft carrier U.S.N.S. Croatan as part of the NASA Mobile Launch Expedition. As the Croatan followed the meridian at 78° west longitude along the west coast of South America, two rockets were launched at 13° south latitude (at the geomagnetic equator), one rocket at 30°S, one at 44°S, and one at 48°S. Launch times were chosen to correspond to a solar zenith angle of 60° at each of the four different latitudes. Each of the payloads carried a radio propagation experiment and a Langmuir probe for the measurement of electron concentration and collision frequency in the lower ionosphere. Between 70 and 90 km, the electron concentration profiles at 13° and 58°S are nearly coincident, and the profiles at 30° and at 44°S are also nearly coincident. This pattern suggests a geomagnetic anomaly in the D region of the ionosphere comparable with the geomagnetic anomaly in the F region. From 90 to 150 km, the profiles show no systematic differences. (auth)

36605 HIGH ATMOSPHERE OF THE EARTH. Dieminger, Walter (Max-Plank-Instituts fuer Aerodynamik, Lindau, Ger.). Umsch. Wiss. Tech., 69: 35-41(Jan. 16, 1969). (In German).

The pressure and density, composition and temperature of the high atmosphere—the atmosphere above 80 km—are described. The ionization processes in the high atmosphere are discussed. The regular variations of the electron density and the irregular variations of the ionosphere are illustrated. The exosphere, radiation belts, and magnetopause are described. (J.S.R.)

36606 THEORY OF ION COLLECTION BY A STATIONARY ELECTROSTATIC PROBE. Cicerone, R. J.; Bowhill, S. A. (Univ. of Illinois, Urbana). Radio Sci., 4: 561-71(June 1969).

The operation of a spherical electrostatic probe in a weakly ionized, collision-dominated gas, such as the D region of the ionosphere, is examined theoretically. A plasma consisting of one type of positive ion, one type of negative ion (or electrons), and a neutral gas is assumed to surround the (stationary) probe. The equations governing the collection of positive ions by a negatively biased probe are developed from a continuum theory of Su and Lam (1963), and are solved numerically. For highly negative probes a method is found to solve the equations in their exact form. Current–voltage characteristics for probes of moderate size in comparison with the Debye length are presented graphically. It is shown that the current to the probe varies approximately as the 0.6 power of the probe voltage, which varies approximately with the ratio of probe radius to Debye length. The current also varies approximately as the 0.75 power of the positive ion concentration for D-region conditions. These conclusions show the importance of including space charge in the theory and agree rather well with those of Balmain's (1966) simplified analysis. A considerable improvement is obtained over the results of Su and Lam for the regime of interest. (auth)

36607 SIMPLIFIED METHOD FOR CALCULATING THE SUPPLEMENTARY ATTENUATION DUE TO AURORAL ABSORPTION FOR DISTANCES LESS THAN 4000 Km. Itu, Pietro Bronzini. Telecommun. J., 36: 29-32(Jan. 1969).

The supplementary attenuation which electromagnetic waves undergo when they pass through the auroral zone is calculated by the Technical Department of the International Frequency Registration Board (IFRB) by means of the instructions for the use of field intensity charts prepared by the Provisional Frequency Board in 1948. A rapid method of calculation was developed, merely requiring the use of an attached polar chart and a diagram. The older "brown booklet" method is reviewed. Basic principles of the simplified method are discussed. (BBB) (TSS)

36608 MODEL ELECTRON DENSITY PROFILES FOR THE LOWER IONOSPHERE. Beynon, W. J. G.; Rangaswamy, S. (University Coll. of Wales, Aberystwyth). J. Atmos. Terrest. Phys., 31: 897-903(July 1969).

The Sen–Wyller generalized magnetoionic theory was applied to experimental data on ionospheric absorption and virtual heights at frequencies near 2 MHz, and it is shown that in the lower ionosphere, over the height range 65 to 95 km, the electron density distribution can be represented by a function of the form $N(h) = N(h_0)e^{a_2(h-h_0)+a_3(h-h_0)^2}$. Sample model profiles were computed for a range of ionospheric conditions and compared with profiles published by other workers. (auth) (UK)

36609 F-REGION IONIZATION AND HEATING DURING MAGNETIC STORMS. Chandra, S.; Herman, J. R. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 17: 841-51(May 1969).

The continuity and heat conduction equations for electrons, ions, and neutral species are solved simultaneously from the viewpoint of studying the F-region magnetic storm behavior. It is shown that many of the observed changes in the F-region during the main phase of a magnetic storm can be successfully explained by assuming a decrease in oxygen concentration at the turbopause level. The specific changes in neutral composition, electron density, and electron, ion, and neutral temperatures during magnetic storms are discussed for different solar conditions. (auth) (UK)

36610 LONG-RANGE BACKSCATTER FROM F-REGION IRREGULARITIES. Dearden, E. W. (Univ. of Queensland, Australia). J. Atmos. Terrest. Phys., 31: 959-69(July 1969).

A particular type of radio echo from the south, observed at Brisbane by a propagation mode involving one F-region hop, is shown to arise from irregularities in F-region, not E-region. The irregularities may be field-aligned and lie high in the layer. The echoes are only observed when a decreasing horizontal ionospheric gradient, which can partially duct rays, exists south from Brisbane. Variously disposed echoes from areas of irregularities, and the propagation modes involved, are discussed for a particular record. (auth) (UK)

36611 MOLECULAR OXYGEN MEASUREMENTS FROM 100 TO 150 km AT WOOMERA, AUSTRALIA. Wildman, P. J. L.; Kerley, M. J.; Shaw, M. S. (Meteorological Office, Bracknell, Eng.). J. Atmos. Terrest. Phys., 31: 951-7(July 1969).

Molecular oxygen distributions in the 100 km to 150 km region were obtained by uv absorption spectroscopy from three Skylark rockets launched at Woomera. Values well below those forecast by C.I.R.A. 1965 for a period of mean solar activity were found. The unexpected behavior of the ionization chambers used as uv detectors, at times during all three flights, is described and possible causes suggested. These are principally outgassing from the vehicle and a moisture film on the ionization chamber window. A possible temporary loss of sensitivity due to uv between 1500 Å and approximately 2200 Å is also described. (auth) (UK)

36612 THE INTERPRETATION OF IONOSPHERIC RADIO DRIFT MEASUREMENTS. II. KINESONDE OBSERVATIONS IN MICROSTRUCTURE AND VERTICAL MOTION IN SPORADIC E. Wright, J. W.; Fedor, L. S. (Research Labs., ESSA, Boulder, Colo.). J. Atmos. Terrest. Phys., 31: 925-42 (July 1969).

Dynamic processes in the E-region, resulting mainly in neutral air motions, appear as the direct causes of certain phenomena (e.g., sporadic E) and are also responsible for much of the less obvious variability of the region. Since it is the time variation of the vertical structure which is usually observed, and since the vertical ionization gradients are large, vertical motions are of greatest interest. It is shown that the vertical component of motion of the neutral air, although of relatively small magnitude, cannot be neglected in estimating vertical ion motions. A new "kinesonde" radio sounding system with which three-dimensional structure and motions in the ionsphere may be observed at the ground is described. The kinesonde is a much-elaborated version of the well-known spaced-antenna drift experiment. It obtains digital magnetic tape recordings of the amplitude and RF phase variations of selected echoes on six freely chosen frequencies and on four spaced antennas, simultaneously. The observations are analyzed by a statistically rigorous method in which many of the cross-correlations between pairs of 48 channels are used to determine a four-dimensional (x, y, z, t) "correloid" in a moving (V_x, V_y, V_z) coordinate system. The velocity V is identified with motions at the ionospheric reflection level and other information describes the random motion, spatial scale, and anisotropic properties of the measurements. It is assumed that the calculated velocities approximate those of the neutral wind, and the vertical ion motions which these air motions would induce are inferred. Measurements performed on sporadic E layers give vertical ion velocities ranging from 1–15 m, often upward. In the vicinity of a daytime Es layer the upward velocity is found to decrease with altitude, implying a convergence of ionization toward the sporadic E-layer. Kinesonde measurements are also compared with the time and height variations of several sporadic E-layer sequences obtained by N(h) analysis of ionograms, and are found to account for much of the variation observed. (auth) (UK)

36613 THE DISTRIBUTION OF IRREGULARITIES IN THE ANTARCTIC IONOSPHERE. II. DIURNAL, MAGNETIC, AND SOLAR CYCLE EFFECTS. Stuart, G. F.; Titheridge, J. E. (Univ. of Auckland, N. Z.). J. Atmos. Terrest. Phys., 31: 905-24(July 1969).

Radio signals from the satellite S-66 were recorded at Scott Base (78°S) from October 1964 to February 1968. Fluctuations in the polarization angle of the received signals show the amplitude of small-scale variations in the electron content along the ray path. Results from 12,000 transits were used to map the changes occurring over much of the Antarctic ionosphere. In equinox there was a large diurnal variation with a maximum near local sunset. There was no overall diurnal change in summer, at sunspot minimum, although the density of irregularities was reduced near 05.00 and 18.00 local time. The winter results were similar, except for an additional production of irregularities throughout most of the Antarctic near 04.00 U.T. (corresponding to local noon near the corrected geomagnetic pole). At sunspot maximum the degree of irregularity increased considerably in all seasons, and showed a definite peak near 06.00 U.T., in agreement with F-region and electron precipitation observations. In the polar cap zone, at geomagnetic latitudes greater than 80°, the degree of irregularity showed a large diurnal variation in summer and winter (but not in equinox), with a maximum near sunset. The polar peak showed at latitudes near 80° as an increase in the degree of irregularity from 03.00 to 15.00 local geomagnetic time in summer, and 07.00 to 17.00 in winter. Averaged over the whole of the observed area the ionosphere was most irregular about 12 hr before a maximum in magnetic activity. The degree of irregularity then decreased, reaching a minimum about 1 day after the maximum magnetic activity and returning to normal in a further 3 days. (auth)

36614 DEPENDENCE OF ELECTRON PRODUCTION RATE IN LOW IONOSPHERE ON THE PARAMETERS OF SOLAR COSMIC RAYS AND EARTH ENVIRONMENT. Velinov, P. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 249-51 (1969).

Expressions were obtained by the author previously (Geomag. Aeron., 8: 448(1968)) for the electron production rate in the lower ionosphere as a result of the ionization by solar cosmic rays. In this note, the expressions are generalized and the factors on which they depend are examined. (TSS)

Low-Temperature Physics

Refer also to abstracts 36806 and 36808.

36615 TUNNELING EFFECTS IN A DIRTY SUPERCONDUCTOR: SEMICONDUCTOR JUNCTIONS. Tsuda, Nobuo (Tokyo Univ.). Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A, No. 353, 27p.(Apr. 1969).

Superconducting tunneling effects were observed for $Pb_{0.7}In_{0.3}$–GaAs junctions in the magnetic field which was varied from zero to upper critical fields. Results are explained well with de Gennes' theory above $0.7H_{c2}$ and $0.56H_{c3}$. Gap parameters are also explained well with usual theories of Type-II superconductivity. (NSA of Japan)

36616 MOTION OF THE VORTEX LATTICE IN A DIRTY TYPE-II SUPERCONDUCTOR. Maki, Kazumi (Tohoku Univ., Sendai). J. Low Temp. Phys., 1: 45-58(Feb. 1969).

The transport properties of the vortex state in a dirty type-II superconductor in the high-field region are reexamined experimentally here. It is shown that the previous theory by Caroli and Maki predicts the entropy carried by a single vortex line, which is consistent with recent experiments, provided the expression of the heat current is properly corrected. Furthermore, it is shown that a large heat delivered by vortex lines together with the normal thermoelectric effect, which persists even in the vortex state, results in a large Hall current in the vortex state. This may account for a large Hall effect observed by Niessen et al., in Nb–Ta alloys. (auth)

36617 MEASUREMENTS OF CRITICAL DATA FOR SOME TYPE-II SUPERCONDUCTORS AND COMPARISON WITH THEORY. Hechler, K. (Massachusetts Inst. of Tech., Cambridge); Horn, G.; Otto, G.; Saur, E. J. Low Temp. Phys., 1: 29-43(Feb. 1969).

Critical field curves and quenching curves for a variety of type-II superconductors of B1 (NaCl type) and A15(β–W type) compounds have been measured. The critical field curves have been evaluated for the pertinent parameters of type-II superconductivity. Comparison of the shape of the critical field curves and their initial slope with recent theories by Helfand and Werthamer results in a good agreement. (auth)

36618 CRITICAL DATA OF SOME A15-TYPE SUPERCONDUCTORS IN TRANSVERSE FIELDS UP TO 230 kOe. Otto, G. (Univ., Giessen, Ger.); Saur, E.; Wizgall, H. J. Low Temp. Phys., 1: 19-28(Feb. 1969).

Critical field curves and quenching curves from measurements on the A15 (β–W) type compounds Nb_3Sn, V_3Si, and V_3Ga are given. The critical field curves were extrapolated to zero temperature, and the following zero upper critical fields were found: 245 kOe for Nb_3Sn, 235 kOe for V_3Si, and 208 kOe for V_3Ga. These values lie between the upper and lower limits given by theories for critical fields, not taking into account spin–orbit scattering. Critical currents for Nb_3Sn samples with small admixtures of zirconium are higher than for corresponding samples without zirconium. Special samples of Nb_3Sn multiwires 522 have still higher critical currents in the high-field region up to 230 kOe. (auth)

36619 INSTABILITY OF A SUPERCURRENT IN THE CRITICAL DEPAIRING REGION. Schmid, Albert (Stevens Inst. of Tech., Hoboken, N. J.). J. Low Temp. Phys., 1: 13-18(Feb. 1969).

Considering the proposal of Fulde and Ferrell on electron depairing in superconductors, the stability of the supercurrents in the critical depairing regime is investigated, where the supercurrent decreases with increasing momentum of the Cooper pairs. It is found that this region is unstable and that disturbances (due to fluctuations) grow exponentially in time. (auth)

36620 TEMPERATURE DEPENDENCE OF THE CRITICAL CURRENT IN ALLOYS WITH A RIGIDLY PINNED VORTEX LATTICE. Bychkov, Yu. F.; Vereshchagin, V. G.; Zuev, M. T.; Karasik, V. R.; Kurganov, G. B.; Mal'tsev, V. A. (Lebedev Inst. of Physics, Moscow). JEPT Lett. (USSR) (Engl. Transl.), 9: 271-4(Apr. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 451-6(Apr. 20, 1969).

To explain superconducting properties of alloys containing finely dispersed nonsuperconducting particles, a model of a rigidly pinned vortex lattice was proposed previously. Here, it is shown that a direct consequence of this model is an unusually rapid growth of the density of the critical current of j_c with decreasing temperatures. This growth does not fit in the framework of the existing theories. The indicated conclusion has been confirmed experimentally. (M.H.R.)

36621 CRITICAL CURRENT OF A SUPERCONDUCTING FILM IN A MIXED STATE. Shmidt, V. V. JETP Lett. (USSR) (Engl. Transl.), 9: 301-2(Apr. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 494-6(Apr. 20, 1969).

It is noted first that the statement that the mixed state is absolutely unstable with respect to a transport current perpendicular to the external magnetic field is, strictly speaking, incorrect. It would be valid for an infinite sample, but even the surface of a real sample can serve as the homogeneity on which the vortex motion can become pinned. The critical current for a film placed parallel to an external magnetic field is calculated. The case when there is no transport current is considered first. (M.H.R.)

36622 A LARGE DESORPTION CRYOSTAT FOR RESISTIVITY MEASUREMENTS BETWEEN 1.2 AND 19K. Waldorf, D.; Yaqub, M. (Ohio State Univ., Columbus, Ohio). Rev. Sci. Instrum., 40: 1032-4(Aug. 1969).

A large desorption cryostat with a heat leak of about 150 mW is described. With the help of an electronic temperature regulator it is capable of maintaining any temperature between 4.2 and 19.0 K to an accuracy of better than 0.5%, using only 200 g of activated charcoal. (auth)

36623 THERMAL QUENCHING OF THE MIXED PHASE OF He II IN LONG CHANNELS. Chang, Y. W.; Frederking, T. H. K.; Linnet, C. (Univ. of California, Los Angeles). Phys. Lett., 29A: 363-4(June 16, 1969).

A critical-state condition is presented for the thermal quenching of superfluidity in the presence of Gorter–Mellink forces in long insulated channels. Experimental data in good agreement with prediction were obtained. (auth)

36624 PHONON ENHANCEMENT IN ELECTRONIC THERMAL EXPANSION. Munn, R. W. (National Research Council of Canada, Ottawa). Phys. Lett., 29A: 395-6(June 16, 1969).

Recent calculations of the pressure dependence of superconducting transition temperatures permit calculation of the phonon-enhancement contribution to the Grüneisen function for electronic thermal expansion in the normal state. For lead the enhancement exceeds the total measured values. (auth)

36625 EFFECT OF PRESSURE ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF IRIDIUM. Wejgaard, W. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett., 29A: 396-7(June 16, 1969).

The change of the superconducting transition temperature with pressure was measured in iridium. It was found that dT_c/dp =

$-(5.1 \pm 0.9) \times 10^{-7}$ K/atm for pressures up to 11,000 atm. This result is compared with theoretical predictions. (auth)

36626 ANNEALING CONDITIONS AND SUPERCONDUCTING BEHAVIOR OF Nb-BASED A15-TYPE COMPOUNDS. Fluekiger, R.; Spitzli, P.; Heiniger, F.; Muller, J. (Univ., Geneva). Phys. Lett., 29A: 407-8(June 16, 1969).

The ternary system $Nb_3Au_xPt_{1-x}$ shows a maximum of the transition temperature T_c for an intermediate concentration. The influence of annealing conditions on T_c was studied. (auth)

36627 VANISHING KNIGHT SHIFT IN DIRTY SUPERCONDUCTING ALUMINUM FILMS. Fine, H. L. (Yeshiva Univ., New York. Brookhaven National Lab., Upton, N. Y.); Lipsicas, M.; Strongin, M. Phys. Lett., 29A: 366-7(June 16, 1969).

The BCS–Yosida dependence of the Knight shift is obeyed in Al films, even when the mean free path is of the order of 5 Å. (auth)

36628 THE BEHAVIOR OF CARBON RESISTOR THERMOMETERS IN MAGNETIC FIELDS UP TO 100 kOe IN THE PUMPED LIQUID HELIUM AND HYDROGEN TEMPERATURE RANGES. Belanger, B. C. (General Electric Research and Development Center, Schenectady, N. Y.). Rev. Sci. Instrum., 40: 1082-5(Aug. 1969).

Previous work has shown that the magnetoresistance of carbon resistor thermometers in applied magnetic fields below 50 kOe for temperatures in the liquid hydrogen and/or liquid helium range exhibits a quadratic dependence on field. This present investigation of the magnetoresistance of $\frac{1}{10}$ W, 100 Ω nominal room temperature resistance Allen–Bradley carbon resistors in fields up to 100 kOe reconfirms the fact that the magnetoresistance increases as H^2 for low fields, but indicates that a modification of this simple result is necessary for accurate thermometry in fields above 50 kOe. It is shown that the percentage change in resistance due to the application of a magnetic field as a function of temperature and field can be described by the equation $100\Delta R/R = CH^2T^{-1.5}/(1 + H^2H_0^{-2})$, where R is the resistance in zero field, ΔR the change in resistance when a field H is applied, and T the temperature. C is a constant which depends on the room temperature resistance of the thermometer, and H_0 is an adjustable constant. Temperature accuracies of the order of 25 mdeg in an ambient field up to 100 kOe may easily be obtained. (auth)

36629 INTERMEDIATE ISOTOPE EFFECT IN SUPERCONDUCTING CADMIUM. Palmy, C. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett., 29A: 373-4(June 16, 1969).

The superconducting transition temperatures were measured on 7 cadmium isotopes and on a natural sample. The isotope effect coefficient α in the equation $T_c \propto M^{-\alpha}$ was found to be 0.32 ± 0.07. (auth)

36630 EXCITATION SPECTRUM INDUCED BY THE PROXIMITY EFFECT BETWEEN COPPER AND SUPERCONDUCTING LEAD. Freake, S. M.; Adkins, C. J. (Royal Society Mond Lab., Cambridge, Eng.). Phys. Lett., 29A: 382-3(June 16, 1969).

High-resolution measurements of the density of states for excitations resulting from the proximity effect between copper and superconducting lead are reported that show well-defined energy gaps and are in qualitative agreement with McMillan's theory. (auth)

36631 ENERGY DISSIPATION IN THE FLOW OF SUPERFLUID HELIUM AND THE CRITICAL VELOCITY. Van Alphen, W. M.; De Bruyn Ouboter, R.; Taconis, K. W.; de Haas, W. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 40: 469-89(Jan. 20, 1969).

A study of the energy dissipation in the flow of the superfluid component of liquid helium in wide chambers (6 to 1 mm) and slits (150 to 15 μm) was performed by means of a calorimetric technique. In the experiments the normal component is clamped by means of superleaks. The critical velocities obtained from these experiments are discussed and compared with those of other experiments; it is shown that the superfluid critical velocity varies with the fourth root of the channel diameter and is temperature-independent. (auth)

36632 CRITICAL FLOW RATE OF SUPERFLUID HELIUM THROUGH NARROW PORES. Van Alphen, W. M.; De Bruyn Ouboter, R.; Olijhoek, J. F.; Taconis, K. W. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 40: 490-6(Jan. 20, 1969).

The critical flow rate of superfluid helium through jeweller's rouge and vycor glass is measured as a function of the temperature. The flow rate is found to be practically independent of the applied pressure head and proportional to the superfluid density, indicating that the velocity is temperature-independent in the temperature region lower than 50 mdeg below the lambda temperature. (auth)

36633 CRITICAL TEMPERATURE OF SUPERCONDUCTING TRANSITION IN NON-IDEAL CRYSTALS. Maksimov, E. G. JETP Lett. (USSR) (Engl. Transl.), 9: 319-21(May 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 527-30(May 5, 1969).

Formulas are developed, starting with the ion-density correlation functions of Van Hove for slow neutron scattering, showing the change of critical temperature to be related to structural changes, rather than to impurities. (L.M.T.)

36634 PEAK EFFECT IN A TYPE-I SUPERCONDUCTOR (LEAD). Levy, H.; Meincke, P. P. M. (Univ. of Toronto). Appl. Phys. Lett., 14: 387-8(June 15, 1969).

The peak effect was produced in lead in the intermediate state near $0.8\ H_c$, where flux motion is known to occur. The field-independent pinning centers were introduced by spark-drilling small holes through the sample. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 35544.

36635 (NP–17598) ANNUAL REPORT, 1966. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 122p. (In German). Dep.

In the Experimentelle Abteilung I, the emphasis was on fast discharges with high temperatures and high densities. The devices used are theta-pinch installations. The largest of these installations (ISAR I) was operated with temperature over 5 keV. The effect of complicated geometries on the dynamic behavior and stability of the plasma was studied. An experiment on collision-free compression and turbulence heating was initiated. Work begun earlier in the MPI was extended to a toroidal theta pinch with superposed hexapole field (SPINNE), in which the particle loss was investigated at higher energies. Various measurement methods for the theta-pinch plasma, such as neutron diagnosis, particle energy analysis, and magnetic field measurements by means of the Faraday effect, were developed. Emphasis was placed on the improvement of the scattered light method. The ion and satellite lines in a relatively cold theta-pinch plasma were measured at 90° scattering. In a forward scattering experiment on a hot ($T_i \approx$ 100 eV) plasma, a spectral resolution of the ion lines was obtained and direct assumptions on the ion temperature could be made. In the Experimentelle Plasmaphysik Abteilung 2, work on containment of plasmas with low pressure in toroidal installations was continued. The particle loss rates of a stationary cesium plasma produced by contact ionization was studied in an installation of the stellarator type and in a toroidal octopole installation constructed of four ring internal conductors. In the Experimentelle Abteilung 3, a high-density quasi-stationary plasma in a strong axial magnetic field was investigated. In Abteilung Theorie, most of the studies were made on equilibrium and stability in toroidal configurations, especially of the stellarator type. With respect to the existing differences in the experimental results on the confinement of plasmas in various stellarators, the case of negligible recoil of the plasma was studied by numerical and analytical methods. (J.S.R.)

36636 (NP–17732) ANNUAL REPORT, 1967. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 157p. (In German). Dep.

In the Experimentelle Abteilung I, fast gas discharges were investigated. The effect of the field inhomogeneities, proceeding from homogeneous magnetic fields, which are unavoidable in a transition to a closed ring arrangement, was determined. A large number of studies in the area of very high temperatures was carried out with the theta-pinch arrangement, ISAR I. Work of the Experimentelle Abteilung 2 was divided into three problem areas. The first was concerned with the behavior of model plasmas of relatively well-known properties in relatively complicated magnetic arrangements. In the second, studies were concentrated on the interaction of a plasma and the radiation emitted by it in interactions with solid walls. In the third, properties of plasma in a magnetic field and its interaction with radiation of various frequency or with particle beams were investigated. In the Experimentelle Abteilung 3, experiments on the stationary heating of a plasma in strong external magnetic fields were continued. The work of the Abteilung Theorie comprised the broad range from studies devoted to basic questions for understanding the plasma behavior to studies directly concerned with evaluation or preparation of concrete experiments. (J.S.R.)

36637 PLASMA PHYSICS INDEX. Bibliography, Author Index, Subject Index. Volume 4, Number 5, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 266p.

A listing is presented of 551 articles on various aspects of plasma physics. Subject and author indexes are included. (M.O.W.)

36638 PLASMA PHYSICS INDEX. Volume 4, Number 4, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 256p.

510 articles on various aspects of plasma physics are listed. Subject and author indexes are included. (M.O.W.)

36639 PLASMA PHYSICS INDEX. EXPERIMENTAL AND THEORETICAL PLASMA PHYSICS. Volume 3, Number 10, 1968. Hilsenbeck, D. (comp.). AED Bibliographien zur Kernforschung und Kerntechnik. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1968. 238p. (AED-C-03-25).

239 articles on various aspects of plasma physics are listed. Subject and author indexes are included. (M.O.W.)

36640 PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH. Third International Conference Held at Novosibirsk, USSR, 1-7 August 1968. Nucl. Fusion, Spec. Suppl., 1-275(1969). (CONF-680805-(Suppl.)).

English translations of the Russian papers.

The 35 Russian papers presented at the subject conference appear here translated into English. Abstracts of these papers plus 90 others appear in NSA Vol. 23, No. 16. For the leading abstracts of the two Volumes of the Proceedings, see NSA 23: 32306 and 32307. (M.O.W.)

36641 PLASMA PHYSICS: TECHNOLOGY INDEX. Bibliography, Author Index, Subject Index, Appendix. Volume 3, No. 5, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 109p.

237 articles on various aspects of plasma physics are listed. (M.O.W.)

Confinement and Heating

Refer also to abstracts 36705 and 37054.

36642 (FTI-218) TURBULENT HEATING OF PLASMA IONS DURING THE GROWTH OF ELECTRON-ACOUSTIC INSTABILITY. Sizonenko, V. L.; Stepanov, K. N. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 20p. (In Russian). Dep.

Studies of weak turbulence in plasma with hot ions and cold electrons revealed that small-scale hf electron-acoustic instabilities developed by ion motion relative to electron motion in the electric field. The motion developed along a circle of low-frequency electromagnetic waves with frequency of the order of the ion cyclotron frequency ω_{Hi}. It is shown that during the span of time $1/\omega_{Hi}$ in the system, rotating along with the wave, a stationary spectrum of electron-acoustic pulsations appeared, with a sharp maximum in the space of wave vectors $\vec{k}$ that exceeded the level of thermal noises by several orders of magnitude. Ion scattering by electron-acoustic oscillations resulted in increases, transverse in relation to the external magnetic field, of the thermal energy of the ions. Expressions are derived for the spectral intensity of electron-acoustic fluctuations, taking into account their nonlinear self-interactions, and a quasi-linear equation was developed for the background function of ion distribution determining turbulent ion heating. The time span of heating was also found. Experiments were performed on plasma heating by ion-cyclotron and fast magneto-acoustic waves, in which abnormal wave absorption was observed. The observed abnormality was due to excitation of a plasma beam instability in the electric field of these waves and, in particular, by excitation of electron-acoustic instabilities. (tr-auth)

36643 (GA-9226) PLASMA TRANSPORT AND FLUCTUATIONS IN A TOROIDAL QUADRUPOLE. Yoshikawa, Masaji; Ohkawa, Tihiro (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 31, 1969. Contract AT(04-3)-167. 12p. (CONF-690803-1). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The plasma transport rate in the toroidal quadrupole at Gulf General Atomic is calculated from the properties of fluctuations. The transport rate is compared with the density decay time. The fluctuation-induced diffusion is consistent with the observed decay time, except near the separatrix. Within an ion orbit of the separatrix additional transport processes are required to account for the observed decay time. (auth)

36644 (IAE-1656) STUDY OF ENERGY LOSSES AND EFFECTIVENESS OF TURBULENT HEATING OF PLASMA BY CURRENT. Kalinin, Yu. G.; Lin, D. N.; Ryutov, V. D.; Skoryupin, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1968. 20p. (In Russian). Dep.

Turbulent heating and energy losses from a plasma in an open trap were studied. It is demonstrated that the effectiveness of heating increases with the expansion of the magnetic field in which the heating is conducted, and with the rise in the initial density of the charged particles in the trap. The maximum effectiveness of the heating achieved in the experiments is 25%. The authors link the heating of the plasma with the development of ion-acoustic instability. During the turbulent heating, there is an appreciable transport of the plasma energy both across and along the sustaining magnetic field, reducing significantly the plasma's energy content. By reducing these losses, one can probably increase greatly the integral effectiveness of the heating. (JPRS)

36645 (JUL-567-PP) ANNUAL REPORT OF THE THEORETICAL AND EXPERIMENTAL GROUP FOR THE YEAR 1967. Geissler, E. (comp.) (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Dec. 1968. 78p. (In German). Dep.

The theoretical group considered waves of finite amplitude in plasmas with magnetic field, kinetic theory of plasma and magnetic field, adiabatic invariance and magnetic field calculations, numerical calculations of the dynamics of the theta-pinch, boundary-value problems of the nonaxial symmetrical coil, and the structure of stationary boundary layers between plasmas and magnetic fields. The experimental groups investigated the production and confinement of plasmas, plasma properties in the vicinity of the thermal equilibrium and diagnostic methods, collision waves in collisionless plasmas, acceleration of plasmas, and incompletely ionized plasmas. Construction and design work done in support of the experimental studies are described. (J.S.R.)

36646 (NP-17945) MECHANISM OF RESONANCE HEATING OF ELECTRONS IN BEAM-PLASMA DISCHARGE. Zalesskii, Yu. G.; Nazarov, N. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 10p. (In Russian). Dep.

The mechanism of resonance heating of electrons in a beam-plasma discharge, previously described by Yu. G. Zalesskii et al. (Plasma Physics and Problems in Thermonuclear Control, Publishing House of the Academy of Sciences, UkrSSR, 1966) may be explained by the excitation taking place in a system of electron-cyclotron waves following damping in the plasma. The frequency of electron-beam wave excitation was determined by the magnetic field geometry at the point of beam entrance into the system. (tr-auth)

36647 (NP-tr-1798) PLASMA ENERGY LIFETIME AND DISCHARGE PARAMETERS IN TOKAMAK-3. Gorbunov, E. P.; Mirnov, S. V.; Strelkov, V. S. Translated for Culham Lab., Abingdon, Eng., from report IAE-1681. 27p. (CTO-619). Dep.

The thermal isolation of plasma in TOKAMAK-3 is discussed. The plasma energy lifetime τ_E was plotted against the following discharge parameters: the stabilizing magnetic field H_z, the particle density n_e, and the discharge current I. In the region of densities $n_e \geq 2 \times 10^{13}$ cm^{-3} τ_E is practically independent of H_z, in the region $n_e \sim 1$ to 5×10^{13} cm^{-3}, τ_E increases slightly with n_e, and proportionally with the current I. The experimental results conform satisfactorily to the empirical formula $\tau_E \sim a^2 H\varphi$. (auth)

36648 UPPER BOUND ON PLASMA CONTAINMENT. Hurley, James (Univ. of California, Davis). Phys. Fluids, 12: 1494-7(July 1969).

Since a plasma cannot be self-contained, it may be supposed that a given external magnetic field is capable of confining only a finite amount of plasma. Two general classes of confined plasmas are considered, and upper bounds are obtained for the total particle energy as simple functionals of the given confining field. As a particular example, the upper bound is evaluated for the Van Allen belts. (auth)

36649 AN INSULATED, EASILY MOUNTED VACUUM SEAL FOR ECCENTRIC TUBES. Young, Marvin P. (Naval Research Lab., Washington, D. C.). Rev. Sci. Instrum., 40: 1112-13 (Aug. 1969).

A simple vacuum seal for the ends of eccentric tubes was constructed by molding a polyurethane housing with a constricting O-ring surface. This type ring is being used for the plasma containment tube in NRL's Pharos experiment. (B.G.D.)

36650 LOCAL ION HEATING DUE TO ELECTRONS TRAPPED ALONG MAGNETIC FIELD. Uramoto, J. (Nagoya Univ., Japan). Phys. Lett., 29A: 411-12(June 16, 1969).

A local ion-heating region appears in a collisionless magneto-plasma, where a transverse electric field produced by electrons trapped along B between two ends, is so large that an azimuthal drift exceeds an ion thermal velocity. (auth)

Diagnostics

Refer also to abstracts 36664 and 36706.

36651 (FTI-165) EXTENSION OF THE LIMITS OF MEASUREMENT OF PLASMA DENSITY BY MEANS OF A LASER INTERFEROMETER WITH PHASE MODULATION OF THE OPTICAL SIGNAL. Dushin, L. A.; Privezentsev, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 8p. (In Russian). Dep.

A laser interferometer, capable of measuring nL of plasma from 10^{14} to 10^{17} el/cm^2, is discussed (n is electron density and L is path length signal). (TSS)

36652 (NP-17950) SPECTRAL AND MICROWAVE STUDIES OF THE DECAY OF A HIGHLY IONIZED HYDROGEN PLASMA. Brand, G. F.; Heckenberg, N. R.; Watson-Munro, C. N. (Sydney Univ. (Australia). School of Physics). Jan. 1969. 21p. (ER-42). Dep.

The decay of a close to fully-ionized hydrogen plasma immersed in a magnetic field of 1 tesla was investigated spectroscopically and with microwave interferometers at 35 and 120 GHz. It has been found that the plasma decays approximately exponentially in time and that the density-temperature relations in the contracting central column are adequately described in terms of the theoretical predictions of Bates, Kingston, and McWhirter down to densities of about 1×10^{19}m^{-3} and temperatures of 2000°K. Competing processes of axial and transverse diffusion have been shown to play no significant part in the decay of this plasma. (Australia)

36653 (NP-tr-1789) DETERMINATION OF THE PARAMETERS OF A PLASMA FORMED BY THE EFFECT OF MICROWAVE POWER IN A MAGNETIC FIELD STEADY-STATE CONDITIONS. Anisimov, A. I.; Vinogradov, N. I.; Golant, V. E.; Nanobashvili, S. I.; Pakhomov, L. P. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translated for Culham Lab., Abingdon, Eng., from report FTI-115. 13p. (CTO-614). Dep. CFSTI.

A plasma was produced by using microwave power in the 3-cm-wavelength range in the electron cyclotron resonance condition. Measurements were carried out in hydrogen at pressures of 5×10^{-4} to 10^{-2} torr and an applied microwave power of the order of 200 W. The steady-state charged-particle concentration was in the range from 10^{11} to 10^{13} cm^{-3}, and the electron temperature from 1.5 to 15 eV. The experimental results are analyzed on the basis of the balance equation. (auth)

36654 MEASUREMENT OF PLASMA TEMPERATURE BY ABSORPTION OF RESONANT LASER RADIATION. Wheeler, C. B.; Troughton, J. (Imperial Coll. of Science and Tech., London). Plasma Phys., 11: 391-6(May 1969).

A method of evaluation of plasma temperature by measurement of its transmission coefficient with respect to radiation that has a resonance with one of the plasma emission lines is proposed. The optical thickness of this line can be calculated if the Saha-Boltzmann relation is valid, and this is very sensitive to temperature and very insensitive to electron density. The laser used as radiation source must be powerful enough to prevent the self-emission of the plasma interfering with the measurement, but not so powerful that it disturbs the population densities in the plasma. Limits on the laser power are calculated, and there is a margin of 10^7 for most experimental plasmas. Calculations show that this method may be used to measure the temperature of an argon plasma if it lies between 15,000 and 20,000°K to an accuracy of 1% using an Ar II laser operated at λ4880 Å wavelength. No knowledge of the electron density is required except that it should lie between 4×10^{16} cm^{-3} and 2×10^{20} cm^{-3}. (auth) (UK)

36655 MEASUREMENT OF FARADAY ROTATION IN A THETA-PINCH PLASMA. Prinn, B.; Barrault, M. R. (Liverpool Univ.). J. Phys., D (London), 2: 1013-20(July 1969).

An arrangement allowing both good spatial and temporal solution of the Faraday rotation effect in plasmas was studied. Some experimental results obtained on a theta pinch are presented. (auth) (UK)

36656 CURRENT MEASUREMENT WITH SELF-INTEGRATING ROGOWSKI COIL. Bertoldi, W.; Kressner, H.; Poeschel, C. (Physikalisch-Technisches Inst., Berlin). Exp. Tech. Phys., 15: 381-95(1967). (In German).

It is shown that, in an infinitely thickly wound closed coil of constant cross section, the induced voltage is independent of the placement of the current-carrying conductor in the coil. At finite, but sufficiently thick winding, the error that arises through an unsymmetric placement of the conductor with reference to the Rogowski coil is negligible for practical purposes. The calculated data for the coil and the experimental data agree well. For self-integrating Rogowski coils, an integration quality was developed that makes it possible to indicate quantitatively the errors occurring through the measuring arrangement. Formulas and diagrams for the optimum construction of coils for stated measurement problems are given. The calculated results are in good agreement with experimental values. It was found that for pulsed-circuit measurements, self-integrating Rogowski coils, sized according to the relations given, gave intricate chronological current patterns with high accuracy. (tr-auth)

36657 DETERMINATION OF THE DENSITY PROFILE IN A PLASMA SLAB. Baldwin, David E. (Yale Univ., New Haven); Kaufman, Allan N. Phys. Fluids, 12: 1526-7(July 1969).

A simple formula is derived, for the direct determination of the electron density profile of a symmetric plasma slab, in terms of the ac resistance of the slab as a function of frequency. The cold-plasma approximation is used. (auth)

36658 EFFECT OF MAGNETIC FIELD AND COLLISIONS ON THE ION CURRENT TO A CYLINDRICAL PROBE. Shaw, E. K.; Kino, G. S. (Stanford Univ., Calif.). Phys. Fluids, 12: 1513-18(July 1969).

Using a modified pressure theory the parameters of a dc discharge between concentric coaxial cylinders have been calculated with the plasma approximation. Both ion-neutral collisions and a longitudinal magnetic field have been taken into account in this low- and intermediate-pressure plasma. In the limit of large outer to inner radii and electron Debye length much smaller than the probe radius, the results are applicable to a cylindrical Langmuir-type probe in an infinite plasma. In the free-fall limit, the results for ion current and density are shown to agree closely with previous collisionless and no magnetic field theories. Curves are presented which show quantitatively, for the first time, the effect of collisions and a "low" magnetic field on the ion current at the Tonks-Langmuir boundary. Contrary to what has been assumed in the past, the magnetic field is shown to have a considerable effect on the ion current even though the ion gyroradius is assumed to be much larger than the probe dimensions. At the Tonks-Langmuir boundary the Bohm criteria comes as a natural consequence of the theory. (auth)

36659 "CALORIMETRIC" MEASUREMENT OF THE ELECTRON TEMPERATURE OF A PLASMA IN A COLLISIONFREE SHOCK WAVE. Smolkin, G. E.; Striganova, E. A.; Sholin, G. V. Dokl. Akad. Nauk SSSR, 185: 788-91(Apr. 1, 1969). (In Russian).

If electrons are cooled off primarily by inelastic collisions with neutral particles and incompletely ionized atoms, the electron temperature T_2 behind the shock front can be determined by measuring the increase in plasma concentration $\Delta n = n_2 - n_1$ after a long enough interval of time. Then, $T_2 = (\Delta nI)/n_1$, where I is the average electron energy loss per single ionization event. For hydrogen the value of I is about 27 eV. Shock wave pulses were produced in a constant magnetic field with rise time of 4×10^{-8} sec, a duration of 4×10^{-7} sec, and an amplitude of 1.2 to 1.5 kOe. The electron concentration was measured from the Stark broadening of a Balmer line (Hβ), whose width was determined from its interference picture obtained on a spectrograph crossed with a Fabry-Perot interferometer. The results show that the shock wave causes an increase in plasma density by a factor of 10 to 20. The electron temperature T_2 behind the shock front was found to be 0.3 to 0.5 keV. (TTT)

36660 STARK-BROADENED HYDROGEN LINES AS TEMPERATURE PROBES IN NITROGEN PLASMAS. Buttrey, D. E. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Chem. Phys., 51: 122-8(July 1, 1969).

Trace quantities of hydrogen have been introduced into shock waves in nitrogen to determine the ion density behind the reflected shock by measuring the widths of time-resolved, Stark-broadened, Balmer lines. A 3-in.-diam, stainless-steel, shock tube with a combustion driver was employed for starting down-stream pressures in N_2 of 5.0, 1.0, and 0.5 mm Hg. The temperatures inferred from the measured ion densities are compared with those obtained from the measured starting pressures and incident shock velocities. Agreement to 10% of the ion-density inferred temperatures with the calculated reflected-shock temperatures was found throughout the 50, 25 and 15 μsec of testing time, respectively,

for the calculated conditions of 8800°K and $0.58\rho_0$ (p_1 = 5 mm N_2), 10,000°K and $0.168\rho_0$ (p_1 = 1 mm N_2), and 13,000°K and $0.09\rho_0$ (p_1 = 0.5 mm N_2). Initial overshoots of as much as a factor of 2 were found in the spectral radiation signals for both the p_1 = 1 mm N_2 and the p_1 = 0.5 mm N_2 data. Representative photomultiplier-scope traces of radiation signals from the 3914-Å (0, 0) N_2^+ first negative system, the 5666-Å multiplet of N II, and the nitrogen continua processes are discussed in conjunction with the ion-density histories. (auth)

36661 DIAGNOSTIC METHOD FOR A PLASMA IN LOCAL THERMODYNAMIC EQUILIBRIUM. Ya'akobi, B.; Avivi, P. (Hebrew Univ., Jerusalem). J. Phys., B (London), 2: 706-14 (June 1969).

A diagnostic method for determining the temperature and electron concentration of a plasma in local thermodynamic equilibrium is described. If the amplitude of the plasma-creating agent (e.g., current or radio-frequency power) is modulated at various frequencies, there will be a frequency below which the intensity of the emitted light will also show appreciable modulation. This frequency is equal to the reciprocal of the effective cooling time. Calculations were carried out for lithium ionized gas for temperatures in the range T = 5000 to 100,000°K and electron concentration in the range $N_e = 10^{14}$ to 10^{18} cm^{-3}. The cooling time resulting from recombination, bremsstrahlung, and line radiations was calculated for the two cases of weak and strong self-absorption. For any measured cooling time, in the range 10^{-6} to 10^{-1} s, a relation between T and N_e results. Since T and N_e are also interrelated through the Saha equation, both can be determined. The method is applied to the modulated light emitted from lithium wires exploded with a damped oscillatory circuit. The results are found to be in good agreement with those of other methods. (auth) (UK)

36662 PLASMASCOPE: ITS OPERATIONAL FEATURES, DESIGN, AND APPLICATIONS. Dobrokhotov, E. I.; Zharinov, A. V.; Moskalev, I. N.; Petrov, D. P. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 9: 143-55(June 1969).

The specific properties of the plasmascope as a device for investigating the processes which occur in a closed-end plasma chamber immersed in a magnetic field were investigated. Its advantages and possibilities are discussed. The design elements of the plasmascope are described, together with certain techniques employed in its construction. The results are presented of plasmascope experiments with a low-temperature plasma obtained by means of gaseous discharge with an incandescent cathode. On the basis of these results it is possible to estimate the directed-motion velocities of the plasma, the plasma potential and the electric fields, and to obtain a picture of the instantaneous plasma density distribution over the transverse cross-section of the discharge. It is shown that the characteristic states of a discharge can be identified with the help of plasmagrams. (auth)

Kinetics (General)

36663 MAGNETIC COMPRESSION OF AXIALLY SYMMETRIC BRILLOUIN-FOCUSED ELECTRON BEAMS. Seeger, John A. (Univ. of California, Los Angeles). IEEE (Inst. Elec. Electron. Eng.), Trans. Electron. Devices, ED-16: 1-5(Jan. 1969).

High-current density electron beams, used in electron-beam welding and in plasma-beam interaction experiments, because of cathode emission limitations, require compression of the beam, that is, reduction of the beam diameter from its initial diameter at the cathode. High-current density Brillouin-focussed electron beams formed with magnetic compression were studied. The problem was analyzed by numerical calculation of electron trajectories using a digital computer. Electrostatic field data were measured using a resistance network analog. The effect of the magnetic field was calculated as an equivalent potential. An experimental system based on the results of the analysis was designed and tested. A Mueller-type electron gun was found to provide a more uniform current density than a corresponding Pierce-type. Experimental results were in close agreement with design objectives. For an area magnetic compression of 10 to 1, a focused beam approaching ideal Brillouin flow was achieved. (BBB)

36664 ARC PHYSICS. Hoyaux, Max F. Applied Physics and Engineering. Volume 8. An International Series. New York, Springer-Verlag New York Inc., 1968. 315p. $14.50.

The first section deals with the theory of the positive column, cylindrical or noncylindrical, in both high- and low-pressure arcs, the second with wall and electrode phenomena, and the third with plasma diagnostics relevant to arc physics. There are appendices on the Langmuir paradox and Steenbeck's minimum principle. (M.O.W.)

36665 MEAN AND INTERMITTENT FLOW OF A SELF-PRESERVING PLASMA JET. Demetriades, Anthony; Doughman, Ernest L. (Philco-Ford Corp., Newport Beach, Calif.). Contract F04701-68-C-0032. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 713-22(Apr. 1969).

The gas dynamics of a highly heated, ionized turbulent argon jet were found to be self-preserving in the coordinates suggested by rudimentary similarity analysis. The measured electron density in this jet is out of equilibrium with the over-all gas, and similarity in this density does not exist. The turbulent front amplitude of this flow shows the randomness expected of free turbulent flows, and its mean position bears the same relation to the flow "half-width" as in low-speed jets. The intermittency factor and the resultant mean front position and its standard deviation measured with a temperature-sensitive probe are the same as with an electron-sensitive probe. The front wavelength appears to be related to the jet scale as wake front wavelengths are related to the wake scale. (auth)

Kinetics (Experimental)

36666 (AD-681519) FACTORS AFFECTING THE GROWTH OF BOUNDARY LAYERS IN PLASMA ACCELERATORS. Final Report. Marble, Frank E. (California Inst. of Tech., Pasadena. Guggenheim Jet Propulsion Center). Dec. 1968. Contract AF-49(638)-1285. 18p. (AFOSR-69-177-TR). CFSTI.

The aim of the research was to investigate some aspects of the interaction between a seeded plasma and the electrode or nonelectrode walls of plasma accelerators or generators. The problem was complicated over that of conventional plasma flow because a seeded gas was involved, and consequently, the physics of surface-gas interaction required some investigation. The program included experimental investigations of the properties of seeded plasmas, stability of the plasma flow, ionization rates and ionization mechanism, as well as boundary-layer type analysis. The work was divided into three different parts: (1) boundary-layer analysis and gas phase and surface phenomena affecting the electrical properties of potassium-seeded argon, (2) ionization rates and ionization mechanisms in the noble gases, and (3) stability of the plasma flow under the action of electrical and magnetic fields. (auth) (USGRDR)

36667 (FTI-166) INTERACTIONS OF TWO PLASMA CLUSTERS IN THE MAGNETIC FIELD OF THE DIVERTOR. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 10p. (In Russian). Dep.

Experiments performed with plasma injections from two coaxial sources through a magnetic-gap divertor are discussed. Studies were made of the charged-particle capture inside the divertor aperture. It was found that, during injection simultaneously from two sources, the total number of particles captured is considerably smaller than the total number of particles captured during injection from each source separately. The reduced particle capture during injection from two sources was caused by polarization during interactions of plasma flows transverse to the magnetic field, forming a hollow cylinder in the divertor surface region. (tr-auth)

36668 (FTI-167) INTERACTION OF A PLASMA BEAM WITH A PLASMA CYLINDER IN THE MAGNETIC FIELD OF A DIVERTOR. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 9p. (In Russian). Dep.

Penetration of plasma beams (moving across the magnetic field of a divertor) into the hollow cylinder formed near the divertor surface as a result of plasma injection, was studied by means of electric probes, a plasmascope, and a Thomson mass spectrograph. It was found that the front part of the plasma beam penetrated inside the divertor aperture; the tail part stayed on the periphery due to polarization from interaction with the plasma cylinder. (tr-auth)

36669 (IAE-1646) STUDY OF COLLISIONLESS SHOCK WAVES IN A MAGNETIZED PLASMA. Zagorodnikov, S. P.; Smolkin, G. E.; Striganova, E. A.; Sholin, G. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1968. 28p. (In Russian). Dep.

The structure of the front and nature of propagation of direct collisionless shock waves in a plasma in dependence on the Alfvén-Mach number, M_A, is discussed. The jump in the electron temperature at the wave's front is measured spectroscopically. The results are interpreted on the basis of the turbulent dissipation mechanism. At an increase in the M_A number, there occurs a specifically irreversible process evidently associated with the

increase in the effectiveness of the conversion of the magnetic piston energy to the ions' kinetic energy. 16 references. (JPRS)

36670 (IAE-1713) CROSS-SECTION OF ELEMENTARY PROCESSES OCCURRING IN HYDROGEN PLASMA. Balebanov, V. M.; Svishchev, V. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1968. 16p. (In Russian). Dep.

A compilation of cross sections for the elementary processes transpiring in a hydrogen plasma is presented. The dependence of the cross section of each process on the energy of an incident particle in the range of energy values up to 30 keV was investigated. Only those interactions are considered with values in excess of 10^{-17} cm^2 (in the energy range noted) for the ionic–atomic collisions, and in excess of 10^{-18} cm^2 for the electron processes. 30 references. (JPRS)

36671 (NP-17943) INVESTIGATION OF THE GROWTH OF AZIMUTHAL CURRENT AND MICROWAVE RADIATION OF A THETA-PINCH PLASMA. Adamov, I. Yu.; Berezhnyi, V. L.; Dushin, L. A.; Kononenko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 13p. (In Russian). Dep.

Plasma radiation was studied at initial pressure of 10^{-2} to 10^{-1} mm Hg, using an extrasensitive superheterodyne receiver operating at wave lengths of 3.2 cm and 8 mm. The azimuthal current growth of a theta-pinch plasma was investigated by means of the Rogowski loop and a two-loop compensating magnetic probe and correlated with the simultaneous microwave emission. (R.V.J.)

36672 EXPERIMENTS AND CALCULATIONS IN AN INVERSE PINCH. Hoffman, Alan L. (California Inst. of Tech., Pasadena). Phys. Fluids, 12: 1426-35(July 1969).

Experiments on the production of collisional shocks in an inverse pinch magnetohydrodynamic shock producing device are described. These experiments are related to the numerical techniques in an accompanying paper in order to explain the observed phenomena. The position of a shock in the rear of a current sheet driven through argon is accounted for by the calculation of relevant plasma parameters and their comparison to previous similarity solutions. The forward position of a shock in helium and hydrogen is similarily explained. The effect of shock produced dissociation in hydrogen is observed by its effect on the gas conductivity and current sheet diffusion. The detailed influence of Mach number and magnetic Reynolds number on shock position is examined experimentally, and methods are proposed for successfully producing high-speed separated shocks. (auth)

36673 EXPERIMENTAL STUDY OF THE STRUCTURE OF PLASMA SHOCK WAVES IN A FAST θ PINCH. Stamper, J. A.; DeSilva, A. W. (Univ. of Maryland, College Park). Phys. Fluids, 12: 1435-40 (July 1969).

The density, temperature, and magnetic field structures of plasma shock fronts have been observed by means of scattered light, a magnetic probe, and emission spectroscopy. The shocks and initial hydrogen plasma were generated by capacitor discharges through a single-turn coil placed around a cylindrical quartz tube containing hydrogen. Electron velocity distributions (density and temperature) were obtained by analyzing the light scattered at 90° to the incident beam from a Q-switched ruby laser. The observed temperature structure was compared with that calculated from observed particle and current density by assuming local resistive dissipation due to binary electron–ion collisions. Agreement was good in two cases, but, in a case characterized by lower initial $\omega_{ce}\tau(0.6)$, the velocity distribution developed enhanced wings and enhanced heating occurred. These effects indicate a diffusion of high-energy electrons from the hot, downstream region. Ion temperatures, obtained from Doppler broadening of a carbon line, are consistent with compressional heating and thermal conduction across field lines. (auth)

36674 COLLISIONLESS THERMALIZATION OF ELECTRONS IN A BEAM-PLASMA SYSTEM. Wada, J. Y.; Knechtli, R. C. (Hughes Research Labs., Malibu, Calif.). Phys. Fluids, 12: 1497-1506(July 1969).

Collisionless thermalization of a stream of energetic electrons injected into a plasma was observed by means of an electron energy spectrometer. Accurate measurements of the energy distribution of the injected electrons have shown that a mean energy loss as well as an energy spread of the injected electrons occurs when the distance traveled by these electrons through the plasma exceeds 10 to 15 e-folding lengths of the fastest growing plasma wave mode. The effects of electron–neutral collisional damping on collisionless thermalization have also been established. It has been shown that collisionless thermalization can be inhibited if the electron collision mean free path is made small enough, or if the effective plasma thickness is kept smaller than about 20 plasma wavelengths for the injected electrons. These experimental results have been found to be consistent with the theory of double stream interaction between injected electrons and stationary plasma electrons. (auth)

36675 RADIATION FROM A URANIUM PLASMA. Schneider, R. T.; Kylstra, C. D.; Randol III, A. G.; Ohanian, M. J. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 12: 3-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36676 SOME METHODS OF INJECTION OF PARTICLES INTO MAGNETIC TRAPS. Akshanov, B. S.; Bagirov, K. P.; Marinin, V. G. At. Energ. (USSR), 26: 306-7(Mar. 1969). (In Russian).

The method of injection of spiral electron currents into gas-filled traps with magnetic mirrors and producing plasma with parameters of $n \simeq 10^{12}$ cm^{-3}, $T_e \simeq 100$ keV, $n_e \simeq 10^{11}$ cm^{-3}, and $\tau \simeq 0.1$ sec was described previously. Experiments were carried out with larger magnetic fields demanding an injection of a larger number of light charged particles with a large transverse energy. A model was designed for this purpose with a parabolic-shaped cathode enabling simultaneous injection of particles with large and small perpendicular components of velocity. The previously announced method and the method using the suggested scheme were analyzed and compared. Results showed that the efficiency of both methods is practically identical in large magnetic traps ($B_2 > 2$ kg (force)). In traps with magnetic fields not so large ($B_2 \simeq 1$ to 2 kg (force)) the suggested method has the advantage in the excitation of the high and low oscillations and plasma heating, because the total electron flux passes through the trap along the spiral trajectory encompassing the magnetic axis of the system. (R.V.J.)

36677 SPECTRA OF HIGHLY IONIZED NEON AND ARGON IN A PLASMA FOCUS DISCHARGE. Peacock, N. J. (United Kingdom Atomic Energy Authority, Abindgon, Eng.); Speer, R. J.; Hobby, M. G. J. Phys., B (London), 2: 798-810(July 1969).

Valency-electron transitions with up to 4-keV energy in highly stripped ions are produced in the transient pinch which occurs in a coaxial plasma gun "Plasma Focus". New or improved wavelengths for transitions in H-like and He-like neon and argon ions were measured and identified by comparison with Hartree–Fock (HX) calculations of atomic structure made by Cowan in 1966 and 1968. Observed wavelengths of the He-like resonance lines lead to extrapolated values for the ionization potentials of Ar XVII and Ne IX. Inner-shell transitions in less highly stripped ions were also identified. (auth) (UK)

36678 A NEW MODE OF CYCLOTRON RESONANCE MULTIPACTING. Schrader, W. J. (EURATOM-FOM, Jutphaas, Netherlands). Physica, 40: 223-8(Dec. 13, 1968).

A single-wall multipacting discharge is described which can occur in a microwave cavity at a wall which is parallel to the electric field $E_\sim$; a constant magnetic field B_0 somewhat below cyclotron resonance and perpendicular to the wall is required. Secondary electrons liberated at the wall drift along B_0 into the electric field, gain energy in the motion perpendicular to B_0, are driven back by the "grad-E^2" force and in turn make secondaries at the wall. Experimental figures obtained at 3.4 GHz and a few kV/cm are compared with analog computer data derived from single-particle orbits. These data show that the electrons return to the wall with grazing incidence and sufficient energy gain to account for the multipacting. (auth)

Kinetics (Theoretical)

Refer also to abstract 36805.

36679 (AD-682336) TRANSPORT COEFFICIENTS IN A PLASMA WITH COLLISIONS BY QUASILINEAR APPROXIMATION. Li, Kwok-Leung; Jen, Norman C. (City Coll., New York). Aug. 1, 1968. 28p. (AFOSR-68-2879). CFSTI.

The collective behavior of a fully ionized plasma is described by the Boltzmann's equation with Krook's collision term. A small perturbation on the time-independent background distribution function of an infinite homogeneous plasma gives rise to longitudinal plasma oscillations. Consequently, the plasma diffuses in the velocity space. The approach employed is the quasi-linear theory introduced by Drummond, Pines, Vendenov, Velikhov and Sagdeev, who applied it to study the collisionless plasma. As the fundamental result, this theory leads to a set of two equations, the "decay equation" describing the Landau damping, and the "diffusion equation" describing the diffusion of the plasma in the velocity space. (auth) (USGRDR)

36680 (AD-687070) A NEW REPRESENTATION FOR THE CONDUCTIVITY TENSOR OF A COLLISIONLESS PLASMA IN A MAGNETIC FIELD. Fried, Burton D.; Hedrick, C. L. (California Univ., Los Angeles. Plasma Physics Group). Mar. 1969. Contracts Nonr-4756(01); AT(11-1)-34. 18p. (R-46). CFSTI.

Conventional expressions for the conductivity tensor of a collisionless plasma in a uniform magnetic field involve infinite sums of Bessel function terms, each of which is associated with an harmonic of the cyclotron frequency. For many problems, it is much more convenient to have closed form expressions for these infinite sums. This paper shows that a suitable approach to the solution of the linearized Vlasov equation leads directly to such closed forms, thus eliminating the necessity for subsequent resumming. In addition to providing an economical derivation of results important for the case of a uniform plasma, this approach also facilitates the treatment of a plasma with a small density gradient. (auth) (USGRDR)

36681 (SC-CR-69-3173) THEORETICAL INVESTIGATION OF MOMENTUM AND ENERGY TRANSFER FREQUENCIES IN TWO TEMPERATURE PLASMAS. Walters, W. F.; Everett, W. L. (New Mexico Univ., Albuquerque. Dept. of Nuclear Engineering). [1969]. Contract 48-7021. 4p. (CONF-690803-3). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

For Sandia Labs., Albuquerque, N. Mex.

The test-particle method of computing momentum and energy transfer frequencies is discussed. Using the Lenard–Balescu kinetic equation to represent particle interactions the test particle method is employed to compute like-particle and unlike-particle energy and momentum transfer frequencies over the range of T_e/T_i from 1 to 100. (M.O.W.)

36682 (SC-CR-69-3174) DEVELOPMENT OF A MODIFIED CHAPMAN–ENSKOG SOLUTION OF THE LENARD–BALESCU EQUATION FOR TWO TEMPERATURE PLASMAS. Walters, W. F.; Everett, W. L. (New Mexico Univ., Albuquerque. Dept. of Nuclear Engineering). [1969]. Contract 48-7021. 4p. (CONF-690803-2). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

For Sandia Labs., Albuquerque, N. Mex.

In the "classical" Chapman–Enskog method of solution, a very small expansion parameter ϵ is chosen, so small in fact that all collision terms appear in the kinetic equation to the same order in spite of the fact that these terms differ by as much as a factor $(m_e/m_i)^{\frac{1}{2}}$. Although a very exact solution may be obtained, the solution is valid only for a small class of systems very close to equilibrium. Two-temperature plasmas are such that unlike-particle energy transfer is not dominant; hence, the portion of the interaction integral corresponding to unlike-particle energy transfer should, to agree with physical reality, appear in a higher order equation. It is found possible to split the electron–ion interaction integral into a portion which, when moments of the equation are taken, accounts for momentum transfer and another portion which accounts for energy transfer. It is thus possible to identify, without ambiguity, a parameter $\epsilon = (m_e/m_i)^{\frac{1}{2}}$ which is appropriate to this class of systems. It is noted that, at a small expense in accuracy (terms $O(\epsilon)^2$ are neglected), it is found possible to develop a rigorous method of solving the Lenard–Balescu kinetic equation for this important class of nonequilibrium fully ionized plasmas. (auth)

36683 A NEW MODEL FOR THE MAGNETOHYDROSTATIC CAVITY FORMED ROUND A LINE DIPOLE–LINE CURRENT COMBINATION IN A PLASMA AT UNIFORM PRESSURE. Hewson-Browne, R. C. (Univ. of Sheffield, Eng.). Quart. J. Mech. Appl. Math., 22: 55-64(Feb. 1969).

The cavity formed round the magnetic field of a line dipole–line current combination by an infinitely conducting plasma at uniform pressure is investigated. The various cases which arise as the current strength increases from zero are considered and it is shown that when the current strength reaches a critical value plasma becomes trapped just inside the cavity. If the current strength is further increased, the trapped plasma is pushed into the cavity and an associated neutral sheet is formed. (auth) (UK)

36684 NONLINEAR PLASMA THEORY. Sagdeev, R. Z.; Galeev, A. A. Frontiers in Physics Series. New York, W. A. Benjamin, Inc., 1969. 132p. $12.50 cloth; $4.95 paper.

The theory is discussed in terms of three basic interactions: nonlinear wave–wave interaction, wave–particle interaction, and wave–particle nonlinear interaction. The basic mechanism and simple properties of each interaction are discussed along with the application of the interaction to realistic problems. (M.O.W.)

36685 EQUILIBRIUM COMPOSITIONS AND THERMODYNAMIC FUNCTIONS OF ARGON–NITROGEN PLASMA AT ATMOSPHERIC PRESSURE, BETWEEN 5,000 AND 35,000 °K. Capitelli, M.; Cramarossa, F.; Provenzano, G.; Molinari, E. (Univ., Bari, Italy). Chim. Ind. (Milan), 50: 963-71(Sept. 1968). (In Italian).

A computer program was developed for calculating equilibrium compositions and thermodynamic functions of Ar–N plasmas at atmospheric pressure between 5000 and 35,000°K for the whole range of compositions. The calculations were carried out starting from the partition functions of the 11 species which are relevant to the temperature range examined. The computations were performed by an IBM 360/40 computer. The 11 equations defining thermodynamic equilibrium refer to the 11 species e, N, Ar, N^+, Ar^+, N^{2+}, Ar^{2+}, N_2, N_2^+, N^{3+}, and Ar^{3+}. The equilibrium constants could be calculated from about 10^{-45} to 10^6 and equilibrium pressures from 10^{-69} to 1 with a maximum number of iterations of 25. How the program can be extended to other plasmas is explained. Criteria for the evaluation of the partition functions were discussed and a comparison made with previous work on pure plasmas. (BBB)

36686 STUDY OF A SYNTHESIZED PLASMA. Bolzinger, Therese; Manus, Claude; Spiess, Gerard (CEN, Gif-sur-Yvette, France). Plasma Phys., 11: 411-28(May 1969). (In French).

Neutralization of a mercury ion beam ejected from an electron bombardment source is studied. The electrons are emitted from a hot filament located close to the ion source. It is shown that, if the temperature of the neutralizer is high enough, a complete charge and current neutralization occurs. The neutralizer is surrounded by a plasma sheath, which is calculated. The stability of the synthesized plasma resulting from the neutralized beam is investigated. (auth) (UK)

36687 DISPERSIVE PROPERTIES FOR BOUNDED FINITE-TEMPERATURE BEAM–PLASMA SYSTEM. Shoucri, M. M. (Atomic Energy Establishment, Cairo). Plasma Phys., 11: 429-47(May 1969).

A dynamic dispersion relation for a bounded cylindrical beam–plasma system is derived by taking into account the effect of finite temperature, with a sharp interface between the two plasma media present. This relation is obtained by allowing a temperature correction to the dielectric constants used in the cold plasma dynamic solution previously derived by Kitsenko and Shoucri (1968). Conditions for the validity of this temperature correction in the different branches of oscillation are indicated. The interaction of a hot beam with a plasma in a bounded geometry is also studied. (auth) (UK)

36688 FORMATION OF A COLLISIONLESS MAGNETOHYDRODYNAMIC SHOCK WAVE. Murphy, B. L.; Kahalas, S. L. (Mt. Auburn Research Associates Inc., Cambridge, Mass.). Plasma Phys., 11: 449-52(May 1969).

A necessary condition for a detached magnetohydrodynamic shock to form in front of a magnetic field which acts as a piston moving a collisionless plasma is indicated. This condition takes the form of a requirement that the time during which the piston accelerates to the Alfvén speed be greater than a certain value determined by the plasma parameters. Unless this condition is met in an experiment, a detached shock will not form, so that any interpretation of the observations which uses shock theory will be incorrect. (auth) (UK)

36689 LONGITUDINAL INHOMOGENEITIES IN Q MACHINES. Bertotti, B.; Sestero, A. (CNEN, Frascati, Italy). Plasma Phys., 11: 452-6(May 1969).

One of the best methods of producing and studying quiescent plasmas is to use a 'Q machine,' in which an alkali gas is almost completely ionized by contact with hot plates. A longitudinal magnetic field orthogonal to the plates confines the plasma so produced in the middle of a cylindrical chamber. It is widely assumed that the velocity distributions of ions and electrons have a Maxwellian shape; in particular, in discussions of instabilities possibilities possibly produced by radial gradients of density and temperature, the plasma is usually taken to be in thermal equilibrium and uniform along the direction of the magnetic field. It is shown that this is not the correct description of a much more complex equilibrium. (auth) (UK)

36690 STATIONARY ELECTRIC ARC IN A CROSS-FLOW AND TRANSVERSE MAGNETIC FIELD. Hodnett, P. F. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Phys. Fluids, 12: 1441-51(July 1969).

An electric arc is held stationary against a gas flowing trans-

verse to the arc axis by applying a magnetic field prependicular both to the arc axis and the direction of the gas flow. A theoretical analysis of the problem is undertaken for the case where the arc is sufficiently long for a central region of the arc (called the uniform column) to exist where a two-dimensional treatment, in the plane of the gas flow, is adequate. The Reynolds number of the flow is taken to be small compared with one. The technique of matched asymptotic expansions is used to calculate the two-dimensional distributions of the quantities of interest, e.g., the temperature and velocity of the gas. (auth)

36691 EXPANSION OF A PLASMA SHELL INTO A VACUUM MAGNETIC FIELD. Poukey, J. W. (Sandia Labs., Albuquerque, N. Mex.). Phys. Fluids, 12: 1452-8(July 1969).

The problem of an initially spherical, superconducting plasma shell expanding into an ambient uniform magnetic field is solved by approximate analytic and numerical methods. The solution is found to depend on only one parameter, the ratio of the initial kinetic energy of the plasma to the magnetic energy initially displaced by the plasma. The dependence of the solutions on this parameter is studied. A criterion for the stability of the solutions is given. (auth)

36692 NEW RESULTS IN THE THEORY OF THE CLASSICAL ELECTRON GAS. Cohen, E. G. D.; Murphy, T. J. (Rockefeller Univ., New York). Phys. Fluids, 12: 1404-11 (July 1969).

Three new coefficients are calculated for the expansion of the potential of average force of the classical electron gas in powers of the plasma parameter ϵ and its logarithm, and it is shown that there are divergences in the coefficients of some of the higher-order terms in this expansion. The asymptotic long-range behavior of the potential of average force is found to be $-c_1 \epsilon \exp(-c_2 \xi)/\xi$, with ξ the distance between two electrons in units of the Debye length, $c_1 = 1 + (3/8 \ln 3 + 1/8)\epsilon + \cdots$, and $c_2 = 1 + (\ln 3)\epsilon/8 + \cdots$. Finally, the internal potential energy of the electron gas is calculated through order ϵ^3. The theoretical results agree well with the Monte Carlo computations of Brush, Sahlin, and Teller up to about $\epsilon = 1$. (auth)

36693 CALCULATIONS OF GAS CONDUCTIVITY IN MAGNETOHYDRODYNAMIC SHOCK PRODUCING DEVICES. Hoffman, Alan L. (California Inst. of Tech., Pasadena). Phys. Fluids, 12: 1420-5(July 1969).

The simple scalar conductivity based on electron collisions with other particles is shown to be the governing parameter in determining current sheet diffusion and energy dissipation in magnetohydrodynamic shock producing devices. Simple methods are developed for calculating this scalar conductivity based on previous similarity solutions and experimental measurements of current sheet growth. These methods are shown to be applicable to inverse pinch experiments described in an accompanying paper, where the gas velocity in regions of the current sheet is constant. The position of the shock, through its influence on the gas velocity, is shown to exert a dominant influence on the current sheet diffusion. (auth)

36694 SOLUTION OF THE MILNE PROBLEM FOR THE KINETIC EQUATION OF BHATNAGAR, GROSS, AND KROOK. Stakhanov, I. P.; Shcherbinin, P. P. Dokl. Akad. Nauk SSSR, 185: 286-8(Mar. 11, 1969). (In Russian).

In a number of cases it is necessary to solve the Milne equation for the simplest kinetic equation which takes into account the exchange of particle energies. A binary mixture of gases can be considered, one component of which is absorbed by the wall. If the concentration of this component is small, the distribution function of the second function can be taken as Maxwellian with a temperature T equal to the wall temperature. In determining the distribution function of the component that is being absorbed, it is necessary to solve the Milne equation under definite boundary conditions. This type of problem is encountered in chemical kinetics, in the theory of a low-temperature plasma, and in neutron diffusion theory. The Milne equation is solved by introducing a dimensionless variable and carrying out a Fourier transform. After integration an equation is obtained that is solved by the usual methods of mathematics. Expressions are given for the particle density near the wall, the relation between the particle density at the boundary and the particle flux to the wall, and the average energy carried away by the particles to the electrode with a Maxwellian distribution of velocities. (TTT)

36695 SELF-CONSISTENT SOLUTION OF THE VLASOV-POISSON EQUATIONS FOR BOUNDED, INHOMOGENEOUS PLASMAS. Dorman, G. (Polytechnic Inst. of Brooklyn). Phys. Lett., 29A: 403-4(June 16, 1969).

A self-consistent solution of the linearized one-dimensional Vlasov-Poisson equation is presented for spatially bounded, low-temperature inhomogeneous plasmas. An eigenvalue equation giving the central frequencies and electric fields of the resonance oscillations and a formula for the Landau damping in terms of the resonance fields are given. (auth)

36696 IMPACT THEORY OF THE BROADENING AND SHIFT OF SPECTRAL LINES DUE TO ELECTRONS AND IONS IN A PLASMA. Sahal-Brechot, S. (Observatoire de Paris, Meudon, France). Astron. Astrophys., 1: 91-123(Jan. 1969). (In French).

Stark broadening and shifting of spectral lines are dealt with, physical conditions chosen being those of stellar atmospheres and laboratory plasmas (temperatures varying from about $0.5 \cdot 10^4$ to $2 \cdot 10^4$ °K and densities varying from about 10^{13} to 10^{18} cm^{-3}). (W.D.M.)

36697 COMPTON SCATTERING IN A GAS OF MAXWELLIAN ELECTRONS. Babuel-Peyrissac, J. P.; Rouvillois, G. (CEA, Bruyeres-le-Chatel, France). J. Phys. (Paris), 30: 301-6 (Apr. 1969). (In French).

The relativistic Boltzmann equation is developed for photon transport with non-coherent scattering in the form of a Fokker-Planck equation usable for thermal photons. An expression of the corresponding equation is given in the spherical harmonics approximation. Formulas are derived for energy exchange between radiation and matter. (auth)

36698 RANDOM WALK TO A SIMPLE STATIONARY ELECTRON ENERGY DISTRIBUTION. de Hoog, F. J. (Technische Hogeschool, Eindhoven, Netherlands). Physica, 40: 139-49(Oct. 31, 1968).

The solution by Markoff of the random-flight problem is applied to the calculation of an electron energy distribution. This distribution develops in a gas when a homogeneous constant electric field is present. The electron-electron interaction is neglected and some other classical conditions are supposed to be fulfilled. The introduction of a so called energy-orientation space makes it possible to describe changes in energy and direction of the electron in geometric terms. It is also possible to take into account the elastic losses and by doing so a stationary electron energy distribution is obtained. From the result it can be seen that the form of the exponential factor in the Druyvesteyn distribution can be interpreted as to originate from a combination of diffusion and elastic friction in the energy-orientation space. (auth)

36699 KINETIC DESCRIPTION OF PLASMA IN AN EXTERNAL FIELD. I. GENERAL THEORY. Kuszell, A.; Senatorski, A. (Inst. of Nuclear Research, Warsaw). Physica, 40: 453-68 (Dec. 30, 1968).

The formal solution of the Liouville equation for systems in an external inhomogeneous, nonstationary, electromagnetic field based on perturbation theory is found. A generalization of the Prigogine-Balescu diagram technique is proposed and the time behavior and volume dependence of the new matrix elements are investigated. The kinetic equation in Vlasov approximation in the presence of an external electromagnetic field is rederived. A general master equation is obtained and its asymptotic limit for long times is discussed. (auth)

36700 EXACT FREE ENERGY OF LOW DENSITY QUANTUM PLASMAS. Ebeling, W. (Univ., Rostock, Ger.). Physica, 40: 290-2(Dec. 13, 1968).

The second virial coefficient of quantum plasmas was calculated, using the results of perturbation theory up to the order e^6 and the method of scattering phase shifts for the orders e^{2n} with $n \geq 4$. The results are described. (M.O.W.)

36701 MOTION OF CHARGED PARTICLES IN A SLIGHTLY DAMPED SINUSOIDAL POTENTIAL WAVE. Best, R. W. B. (FOM-Insituut voor Plasma-Fysica, Jutphaas, Netherlands). Physica, 40: 182-96(Dec. 13, 1968).

An adiabatic invariant is derived for the particle's nearly periodic motion. It is shown that this invariant changes little, even during transition between the free and the trapped state for nearly all particles. The time-averaged energy and momentum of a particle are calculated. Free particles are accelerated in a damped wave. The so-called nonlinear Landau damping is discussed finally. (auth)

36702 NOTE ON REDUCED PROBABILITY DISTRIBUTION FUNCTIONS. Weil, J. W. (International Atomic Energy Agency, Vienna). Nucl. Fusion, 9: 171-2(June 1969).

Recently, Floriani (Nucl. Fusion, 9: 1-77(1966)) proposed a general algorithm for determining the time behavior of plasma systems near equilibrium. Floriani mentions a possible application of this method to Boltzmann-type integro-differential equations and

derives recurrence formulas for it. In this note, this proposal is applied to the BBGKY kinetic theory. (M.O.W.)

36703 NONLINEAR THEORY OF CHERENKOV EXCITATION OF A PLASMA BY A MODULATED CHARGED-PARTICLE BEAM. Kurilko, V. I. (Inst. of Physics and Tech., Kharkov); Ullschmied, J. Nucl. Fusion, 9: 129-35(June 1969).

The nonlinear problem of the excitation of a plasma resonator by the Cherenkov emission of a density-modulated, injected beam of charged particles is considered. It is assumed that the beam current and the resonator length are small and that the particle energy is large, so that the transit time is small compared with the characteristic field rise time. The modulation frequency is assumed to be equal to one of the natural frequencies of the resonator. The main nonlinear effect is considered to be the reciprocal influence of the excited field on the motion of the beam particles; the plasma is assumed to be linear. Two nonlinear equations of first order are derived that determines in this approximation the time-dependence of the amplitude and phase of the field in the resonator. The maximum field amplitude and the corresponding phase value are found, and estimates are made of the pulse duration necessary to reach the maximum and of the average beam particle energy losses per pulse. (auth)

36704 NONLINEAR SKIN EFFECT IN A CONDUCTING CYLINDER. Breus, S. N.; Kurdyumov, V. N. (Radiotechnical Inst., Moscow). Nucl. Fusion, 9: 109-13(June 1969).

The penetration into a plasma cylinder of a quasi-stationary electromagnetic field excited by a wave of azimuthal surface current travelling parallel with the cylinder axis and located at some distance from the surface of the plasma was investigated. Since in this instance the variable magnetic field is considerably higher than the electric field its influence on the movement of particles in the plasma was taken into account. Within the limits of a hydrodynamic approximation this factor could be reduced to the inclusion of the Hall current in Ohm's law (σ/enc) $[\vec{j}\vec{H}]$. A solution to the resulting system of nonlinear partial differential equations was found by using a computer program somewhat analogous to the physical process by which field equilibrium distributions are established in a plasma. The dependence of all physical magnitudes on two parameters was studied: the conductivity of the plasma σ and the ratio Ω of the Hall current to the conduction current. Allowance for nonlinear effects leads to the appearance of a constant component of the longitudinal current (the carrier current), whose density never exceeds, at any point of the cylinder cross section, the limiting value corresponding to the movement of all electrons at the phase velocity of the wave. A leakage of current towards the inner region of the plasma cylinder takes place and closed lines of current form in the cross sections φ = const. The depth of field penetration increases with increased nonlinearity, while at high plasma conductivity values the penetration depth is determined only by the value of Ω. Dissipation losses in the plasma are to all practical purposes independent of Ω. (auth)

Production

36705 (UCRL-71775) INTERACTION OF INTENSE PHOTON AND ELECTRON BEAMS WITH PLASMAS. Kidder, Ray E. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 11, 1969. 80p. Dep. CFSTI.

Some of the properties of focused laser beams such as the achievable electromagnetic energy density, electric and magnetic field intensity, and effective beam temperature are described to demonstrate the relevance of laser beams to the physics of high energy density. Then the linear theory of the interaction of light beams with plasmas, together with some simple hydrodynamic considerations, is employed to derive scaling relations for the production of high-temperature and high-pressure plasma, to determine the pressure due to light-induced plasma blowoff, and to consider lightwave-driven detonation waves. These more general topics are then followed by a specific consideration of the production and properties of tenth-microgram multi-kilovolt deuterium and mercury laser-produced plasmas, including the results of detailed computer calculations. Next, some of the nonlinear effects that can occur in the interaction of very intense light beams with plasmas are considered. They are divided into two classes: single-particle and collective nonlinear effects. Finally, the application of high-current pulsed relativistic electron beams to the achievement of high energy density in matter is considered. The penetrating power of energetic electrons through matter contrasts so markedly with that of light beams that one may expect electron pulses and photon pulses to be complementary rather than competing ways of achieving high energy density. (M.O.W.)

36706 TEMPERATURE IN LASER-CREATED DEUTERIUM PLASMAS. Bobin, J. L.; Delobeau, F.; De Giovanni, G.; Fauquignon, C.; Floux, F. (Commissariat a l'Energie Atomique, Villeneuve-Saint Georges, France). Nucl. Fusion, 9: 115-20 (June 1969).

The beam of a powerful neodymium glass laser is focused into a solid deuterium stick. The temperature of the created plasma is measured by Jahoda's x-ray absorption method. The electron temperature has been found to range up to 450 eV and exhibits a $^2/_3$-power dependence on the power flux density. These results are in agreement with a theoretical model involving a strong shock and a deflagration front propagating inwards the D_2 ice whereas the plasma expands in the vacuum towards the incoming beam. (auth)

Stability

Refer also to abstract 37048.

36707 (IAE-1657) HIGH-FREQUENCY STABILIZATION OF POTENTIAL PERTURBATIONS IN PLASMA. Artsimovich, L. L.; Ivanov, A. A.; Luk'yanchuk, A. N.; Rusanov, V. D.; Sobolev, S. S.; Teykhman, I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1968. 16p. (In Russian). Dep.

The stabilization of potential oscillations in a plasma by a high-frequency azimuthal magnetic field was studied. The experiments were run on a Q machine and in the positive column of a gas discharge. (JPRS)

36708 (NP-17953) THEORY OF EQUILIBRIUM AND STABILITY OF HIGH-CURRENT, SELF-CONSTRICTING DISCHARGES IN A DENSE OPTICALLY TRANSPARENT FINITE-CONDUCTIVITY PLASMA. Preprint No. 26. Rukhadze, A. A.; Triger, S. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 42p. (In Russian). Dep.

The work is a continuation of the studies previously reported in NP-17748 (See NSA 23: 12872). Theoretical data on equilibrium and stability of a high-current self-constricting optically transparent plasma are evaluated, considering the volume of the emission. Cases of a simple cylindrical discharge (Z pinch) and discharge with a reverse axial current (inverse pinch) were examined. It is shown that a discharge in an optically transparent plasma with a power instability (constriction and buckling) is subjected also to superheated instability. Under the given conditions ($T \approx 3$ to 5 eV, $n \approx 10^{17}$ to 10^{18} cm^{-3}) the instability developed very rapidly. The increment of various types of instabilities was calculated, and discharge parameters satisfying required duration were determined. (tr-auth)

36709 (ORNL-TM-2639) EVOLUTION AND STABILIZATION OF FLUTES IN A MAGNETIC MIRROR. Colchin, R. J.; Dunlap, J. L.; Postma, H. (Oak Ridge National Lab., Tenn.). June 1969. 46p. Dep. CFSTI.

A hot-ion, low-β plasma was established in an adiabatic, simple mirror trap by Lorentz or gas-collisional ionization of an energetic H^0 beam. The studies emphasize: (1) the detailed evolution of the flute mode and comparisons with linear theory and (2) the stabilizing effects of increased electrical connection of the plasma to conducting end walls (line-tying). The evolution is traced as a function of density from a stable drift wave at low density to threshold for a growing, unstable wave that quickly exhibited nonlinear frequency behavior. Evolution of the stable drift wave is much as predicted by the linear theories. Instability threshold seems to occur at a somewhat higher density than that calculated even from theories treating bounded plasmas. The line-tying experiments used movable end walls as a control on the electrical connection. Threshold was raised with end walls close to the hot plasma in a fashion that is in qualitative agreement with a recent calculation. Two possible explanations of the nonlinear frequency behavior of the unstable wave are proposed. (auth)

36710 (SU-IPR-296) RELATION BETWEEN HELICAL, ION ACOUSTIC, AND DRIFT INSTABILITIES. Crawford, F. W.; Duncan, A. J.; Forrest, J. R.; Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 5p. (CONF-690619-1). Dep. CFSTI.

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

The results from a theoretical study of the various instabilities in positive column discharges are discussed. The conditions for the occurrence of each instability are described. (M.O.W.)

36711 CONCERNING FUNG'S LETTER "TWO METHODS OF SOLVING THE RADIATIVE INSTABILITY PROBLEM OF A

STREAM–PLASMA SYSTEM IN THE KINETIC REGIME". Zheleznyakov, V. V.; Souvorov, E. V. (Radiophysical Research Inst., Gorky, USSR). Plasma Phys., 11: 457-9(May, 1969).

It is suggested that the result obtained in Fung's 1967 paper be re-examined, as it appears to be incorrect, even for the case of a small density of nonequilibrium electrons. (UK)

36712 STABILIZATION OF POTENTIAL OSCILLATIONS OF A PLASMA IN A Q MACHINE BY MEANS OF A HIGH-FREQUENCY MAGNETIC FIELD. Ivanov, A. A.; Kazakov, Yu. B.; Luk'yanchuk, A. N.; Rusanov, V. D.; Sobolev, S. S.; Teikhman, I. JETP Lett. (USSR) (Engl. Transl.), 9: 210-12 (Mar. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 356-60(Mar. 20, 1969).

It was found that the alternating magnetic field suppresses the potential oscillations observed in a Q machine. Typical spectra of the oscillations, with and without a magnetic field, are given. (M.O.W.)

36713 NONLINEAR DYNAMICS OF A SINGLE HARMONIC LOSS-CONE FLUTE MODE. Aamodt, R. E. (Univ. of Texas, Austin); Bodner, S. E. Phys. Fluids, 12: 1471-80(July 1969).

The nonlinear evolution of a single-wavelength, longitudinal flute mode with frequency near a harmonic of the cyclotron frequency is determined. It is shown that only a small-amplitude wave is needed to destroy the linearly coherent contributions of different gyrating particles to the perturbed charge density. This nonlinear smearing of the cyclotron resonance is accomplished by vortex filament motion of the hot particles in phase space, and leads to rapid stabilization and subsequent damping of the linearly unstable resonant modes that occur in hot–cold multicomponent loss-cone systems. In such a system with a typical hot-particle Larmor radius R, a mode with wave vector k gains energy from the low-velocity, inverted population hot particles until an energy is attained of the order $(kR)^{-2}$ times the hot-particle kinetic energy. This field energy then decays, being absorbed by the high-velocity, normally populated hot particles. (auth)

36714 ION CYCLOTRON INSTABILITIES IN SHORT MIRROR MACHINE PLASMAS. Cordey, J. G. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 12: 1506-12(July 1969).

An appropriate finite geometry theoretical model of a magnetic mirror machine is examined for ion cyclotron instabilities. The normal modes of the finite model are shown to be unstable even in the presence of large magnetic field gradients. The effect upon the ion cyclotron instability of particle mirroring is discussed. Electron Landau damping is shown to be stabilizing for these modes, but low mirror ratio machines will require high electron temperatures to stabilize instabilities at frequencies near the high harmonics of ω_{ci}. (auth)

36715 LOW-FREQUENCY INTERCHANGE STABILITY OF PLASMAS FROM THE MAXIMUM ENTROPY CONDITIONS. Santini, F. (FOM–Association Rijnhuizen, Jutphaas, Netherlands). Phys. Fluids, 12: 1522-4(July 1969).

The conditions for the stability of a low-pressure plasma equilibrium against low-frequency interchange modes, including trapped-particle modes, are also conditions for a maximum of the entropy functional introduced in preceding papers. (auth)

36716 INSTABILITY OF LOW-β MAGNETIC FLUTE MODES CAUSED BY TRANSVERSE ANISOTROPY. Morse, Richard L. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 1483-8 (July 1969).

A marginal stability analysis of a symmetric, low-β sheet plasma shows that the shorting of electrostatic potential between magnetic field lines allows the existence of marginally stable magnetic flutes with finite wavelength in the direction perpendicular to $\vec{B}$ and parallel to the plane of the plasma. Two cases are considered. In the small gyroradius limit, the system is shown to be neutrally stable for all wavelengths. In a large gyroradius limit where transverse anisotropy is large, an expression is obtained for the finite wavelength of the marginally stable mode. (auth)

36717 TEMPERATURE GRADIENT INSTABILITIES IN AXISYMMETRIC SYSTEMS. Liu, Chuan Sheng (Univ. of California, Los Angeles). Phys. Fluids, 12: 1489-93(July 1969).

The temperature gradient effect on the stability of a plasma in the "maximum-J configuration" is studied and two possible instabilities due to temperature gradient are found in the axisymmetric system. (auth)

36718 DIRECT MEASUREMENTS OF LINEAR GROWTH RATES AND NONLINEAR SATURATION COEFFICIENTS OF INSTABILITIES. Wong, Alfred Y.; Hai, Francis (Univ. of California, Los Angeles). Phys. Rev. Lett., 23: 163-6(July 28, 1969).

An experimental method of perturbation about a nonlinear equilibrium state is employed to examine linear growth rates and nonlinear saturation coefficients. This procedure is illustrated by the experimental investigation of finite-amplitude unstable-collisional drift waves in a highly ionized plasma. Preliminary experimental results are compared with existing linear and nonlinear theories. (auth)

36719 DETERMINATION OF SUBDOMINANT SOLUTIONS USING A PARTIAL WRONSKIAN. Boris, Jay P.; Greene, John M. (Princeton Univ., N. J.). J. Comput. Phys., 4: 30-42(June 1969).

A simple step-by-step technique is presented for the numerical integration of certain difficult-to-obtain subdominant solutions of systems of ordinary differential equations. These subdominant solutions can be entirely obliterated when integrating with standard numerical techniques if the ever-present error components of the dominant solutions, usually characterized by a strong exponential dependence, increase rapidly in the direction of integration. The technique presented here, to overcome this difficulty for a fourth-order system, can be made quite efficient by proper use of a functional resembling the linear combination of the Wronskians of two distinct second-order differential equations. This "partial Wronskian" gives a useful piece of global information about the desired subdominant solution which permits the error components of the growing dominant solution to be removed numerically long before these errors have grown unacceptably large. The technique is presented initially via a specific example taken from the theory of resistive instabilities in an inhomogeneous hydromagnetic fluid. More general problems are discussed briefly to indicate ways in which the ideas and methods contained in this paper may be modified to treat problems for which a partial-Wronskian functional with the desired properties cannot be found. (auth)

36720 STABILITY OF ELECTRON CYCLOTRON WAVES IN PLASMA. Kalmykova, S. S.; Kurilko, V. I. At. Energ. (USSR), 26: 513-16(June 1969). (In Russian).

Consideration is given to the problem of stability of the phase-matched oscillator system, the phase of which in each plane perpendicular to the external magnetic field is given by the electron wave propagating in the direction of the field. The dispersion equation defining the dependence of the wave distortion frequency and length on the system parameters is derived and analyzed. It is shown that this instability is decay type. The increments are calculated and the fields of instability are determined. It is established that the electron cyclotron wave is stable when the plasma frequency exceeds the electron gyrofrequency. (auth)

36721 DRIFT INSTABILITIES OF A MAGNETIZED TURBULENT PLASMA. Krivorutskii, E. N.; Makhankov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Fusion, 9: 97-108(June 1969).

The influence of a developed high-frequency plasma turbulence on the spectrum and buildup of drift oscillations was studied. It is shown that, even in the case of relatively weak turbulence, $W/n_0 T_e \ll 1$ (W being the turbulence energy), there is a critical value W_{cr} such that when $W > W_{cr}$ the spectrum and buildup of drift oscillations change radically. When $W > W_{cr}$, high-frequency turbulence may lead to stabilization of drift oscillations for large temperature gradients ($d \ln T \; d \ln n_0 > 2$). The analysis is limited by the assumption that the plasma electrons are magnetized, which means that a drift kinetic equation can be used in describing them. The role of both potential and nonpotential turbulent pulsations at frequencies of the order $\omega_{pe} = (4\pi n_0 e^2/m_e)^{1/2}$ and the limiting cases of isotropic and one-dimensional turbulence were considered. A new class of turbulent-plasma instabilities with nonlinear drift is found. (auth)

36722 TRAPPED-PARTICLE INSTABILITIES IN TOROIDAL SYSTEMS. Pogutse, O. P. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 9: 157-67(June 1969).

The effects which promote stabilization of collisionless instabilities are discussed. The influence of the following are considered: (1) unequal ion and electron temperatures; (2) finite orbits; (3) circulating particles; (4) temperature gradient. It is found that it is extremely difficult to achieve complete stabilization of "trapped-particle" instabilities. However, the various stabilizing factors affect the instability most strongly when the particles have different temperatures. (auth)

Thermonuclear Processes

36723 (AD-686715) THETA-PINCH GUN USED TO STUDY HIGH-BETA PLASMA INJECTION INTO MAGNETIC FIELDS.

Turner, R. (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Mar. 1969. Contract NOw-62-0604. 116p. (APL-TG-1064). CFSTI.

A small theta-pinch gun was developed for high-beta injection studies. The gun uses two independently energized coils to create a single doughnut-shaped plasma puff with an average density (in a 2-kG field) of 1 to 2×10^{15} cm^{-3}, ion temperature of 35 eV, and directed energy of 200 eV. The transmission of the plasma along Bz, Ioffe, and linear octopole guide fields and its interaction with a magnetic barrier have been studied with a variety of diagnostics, including a specially developed fast far-infrared interferometer. The results indicate that the theta-pinch gun output, limited by flute instabilities during compression and entry into the guide fields, is significantly greater than that of a more conventional, but comparable conical gun; that the Bz field is a more satisfactory guide field than either the Ioffe or linear octopole field; and that a magnetic barrier can convert a significant amount of directed energy into transverse energy. (auth) (USGRDR)

36724 (FTI-217) MAGNETIC CONFIGURATION WITH WIDTH AND MINIMUM B. Aleksin, V. F.; Romanov, S. S.; Sebko, V. P.; Loktionov, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 17p. (In Russian). Dep.

Studies were made of magnetic configuration of one-, two-, and three settings of the helical field (n = 1, 2, and 3) with axial current. Properties of rotational transformation of magnetic lines of force and magnetic field minimum at the center were examined. A relationship was established for the well and width and the particularities of the structure configuration. Numerical data were obtained for the width and relative depth of wells for each magnetic system (n = 1, 2, and 3). (tr-auth)

36725 (NP-17948) MAGNETIC FIELD STRUCTURE OF A TYPE L-1, TWO-PASS STELLARATOR. Preprint 35. Komin, A. V.; Krasitskaya, L. V.; Minaev, V. P.; Kovrizhnykh, L. M.; Danilkin, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 17p. (In Russian). Dep.

The structure of magnetic surfaces in the peripheral region (near the separatrix) was carried out more accurately by direct calculation of the trajectories of the force lines on a computer. The calculations were carried out for the following variants: (1) a system of magnetic surfaces of a toroidal stellarator created by two different ways of winding the coils ("geodesic" and quasi-toroidal spirals), and (2) the effect of a number of perturbations on the magnetic surfaces of the field. The main perturbation was taken as skewing of the current distribution planes created by the longitudinal and helical field. A horizontal magnetic field was also added as a perturbation along with the perturbation due to skewing. A comparison of these results with previous results in the literature shows that the two sets of results are in good agreement with each other. Computer computations are preferred only when exact, quantitative data on a concrete system are desired. (TTT)

36726 (ORNL-tr-2172) CALCULATION BY COMPLEX ANALYSIS OF THE PLANE MAGNETIC FIELD OF A PARALLEL CONDUCTOR OF FINITE THICKNESS. Gorenflo, R.; Welter, H. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Arch. Elektrotech. (Berlin), 51: 255-61(1967). 10p. Dep. CFSTI.

By complex representation of a plane vector field a finite expression (in elementary functions) is derived for the magnetic field produced by an even number of infinitely long Ioffe bars with nonzero radial and angular extension. (auth)

36727 (SC-RR-69-323) ENERGY-SCALING OF A PLASMA FOCUS DEVICE. Patterson, E. L. (Sandia Labs., Albuquerque, N. Mex.). June 1969. 24p. Dep. CFSTI.

The neutron and x-ray radiation characteristics of a plasma-focus device were investigated as a function of source energy and deuterium filling pressure. Neutron production was found to scale approximately linearly with peak current, but x-ray yield was not dependent in a simple way upon current. A limiting value of peak dI/dt was encountered beyond which significant neutron and x-ray yield was not obtained. (auth)

36728 (SC-RR-69-441) IMPROVED INVERSE PINCH DEVICE: COMPARISON WITH THEORY. Gerber, R. A.; Freeman, J. R. (Sandia Labs., Albuquerque, N. Mex.). July 1969. 33p. Dep. CFSTI.

The inverse-pinch geometry has recently been used in studies involving ionizing and collisionless shocks, blast waves, and current-sheet stability. This work discusses an improved inverse-pinch device capable of achieving higher shock velocities than previously obtained. An exploding wire-dielectric switch is used to increase the rate of current input. The measured luminous front velocities exceed those previously reported for similar ambient hydrogen pressures. The experimental results are compared with a one-dimensional hydromagnetic model. Results of this single fluid hydrodynamic code are shown to compare favorably with the experimental data. (auth)

36729 ARRANGEMENT FOR BRINGING ABOUT NUCLEAR FUSION REACTIONS. Kaiser, Wolfgang. British Patent 1,157,598. July 9, 1969. Priority date Feb. 10, 1967, Germany.

An arrangement is provided for bringing about nuclear fusion reactions, utilizing a system of two synchronously activated lasers emitting light beams focused on targets for the purpose of producing a plasma. The lasers face each other on a common optic axis to emit their light beams towards each other and each light beam is focused on one of two deuterium or deuterium-tritium containing targets, the receiving surfaces of which have cross sections approximately corresponding to the cross sections of the focused light beams of the lasers. The targets are arranged each with their receiving surface symmetrically disposed about the common optic axis of the laser system and symmetrically spaced along the axis with respect to the center plane of separation of said lasers, each target being disposed on that side of said plane remote from its associated objective. (M.O.W.)

36730 COAXIAL CATHODE DESIGN FOR PLASMA SOURCES. Chen, Francis F. (Princeton Univ., N. J.). Rev. Sci. Instrum., 40: 1049-53(Aug. 1969).

The electron-bombardment heated cathode structure described is capable of producing an electron-emitting surface 5.7 cm in diameter at 2700K, with ± 5 K azimuthal temperature uniformity. The coaxial structure allows access along the axis, is assembled from modular components machinable on a lathe, and requires no water cooling internal to the vacuum system. The "cathode" is particularly suitable as an emitting end plate for a thermionic plasma (Q machine). (auth)

36731 CONTROL OF THERMONUCLEAR FUSION. Pease, Rendel Sebastian (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Atomes (Paris), 24: 208-18(Apr. 1969). (In French).

Advances in design of units for the containment of thermonuclear fusion reactions are reviewed. After review of the fundamental reactions of fusion, problems of containment are noted, and the thetatron is noted as the most simple configuration. Control of instability is illustrated by application of a mirror machine and by crossing lines of force. Microinstabilities present the greatest problem to surmount. Practical instruments for confinement have attained diffusion from 0.01 to about 1 times the Bohm diffusion value. Problems of materials, handling of fuel, and extraction of spent materials and energy require consideration for fusion reactor designers; suggestions for a $^2H-^3H$ reactor are incorporated into a conception of such a design based on present knowledge to produce 2,000 to 10,000 MW. (BBB)

36732 ARTSIMOVICH TALKS ABOUT CONTROLLED-FUSION RESEARCH. Tuck, James L.; Lubkin, Gloria B. Phys. Today, 22: No. 6, 54-7(June 1969).

The research status of controlled fusion in the US and USSR is discussed. Future areas for concentration are described. (M.O.W.)

36733 TWO SUGGESTIONS REGARDING CONTROLLED FUSION: APPROXIMATION EQUATIONS FOR FUSION-FISSION REACTORS AND FUSION-REACTION-TUBE REACTORS. Jung, H. (Brown-Boveri/Krupp, Mannheim, Ger.). Nucl. Fusion, 9: 169-71(June 1969).

The approximation equations, including the criticality condition, for an infinitely large fusion-fission reactor are discussed. In addition, the criticality condition for a fusion-neutron-multiplier (n,2n) reactor is considered. The equations show that it is even worth asking with what minimum amount of fissionable material a (fast) fission-neutron-multiplier reactor can be operated. (auth)

Wave Phenomena

36734 (FTI-190) TURBULENT PLASMA IN A STELLARATOR. Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Nikolaev, R. M.; Potapenko, V. A.; Rudakov, V. A.; Tereshchenko, F. F.; Tolok, V. T.; Pavlichenko, O. S. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1968. 11p. (In Russian). Dep.

Data are given on the oscillation processes in plasma which exert a considerable influence on the plasma heating rate and losses in the trap. Experiments were carried out in the "Sirius" stellarator, design and specifications of which are included. An

ohmic discharge with 1-msec current pulse duration was used for plasma heating. The experiments used a neutral helium pressure from 2×10^{-5} to 5×10^{-4} mm Hg, electrical field potential from 0.08 to 0.4 V/cm, and magnetic field from 4 to 16 kOe. The plasma cylinder current, chamber intensity, density and diamagnetism of plasma, density distribution along the plasma cylinder cross section, fluctuations of the floating potential, and x-ray and microwave emissions were recorded and analyzed. (R.V.J.)

36735 (NP-17915) WAVE EQUATIONS APPROXIMATING THE PRECISE SOLUTIONS FOR NONLINEAR ELECTRODYNAMICS AND OPTICS. Preprint 37. Eleonskii, V. M.; Silin, V. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 39p. (In Russian). Dep.

Asymptotic solutions of nonlinear field equations were obtained for singular values of wave vectors in the case in which one-mode solutions by amplitude steps were impossible. Moreover, the above demanded solutions of nonlinear one-dimensional equations for the fundamental mode, and in one case, the use of several harmonic modes. Two-dimensional solutions were constructed for approximating the exact nonlinear periodic one-dimensional waves and the possible wave vector values were found. (tr-auth)

36736 DOMINANT INFLUENCE OF ELECTRON INERTIA ON ION CYCLOTRON-WAVE GENERATION IN PLASMA. Hosea, J. C.; Sinclair, R. M. (Princeton Univ., N. J.). Phys. Rev. Lett., 23: 3-7(July 7, 1969).

Electron inertia is predicted to have a dominant influence on ion cyclotron-wave propagation as the wave frequency approaches the ion cyclotron frequency. This influence should effect a reduction in the Stix-coil coupling to a plasma column as the plasma density is lowered. Experimental coupling measurements, taken over an appropriate range of plasma density (2×10^{10} to 2.8×10^{12} cm^{-3}) on the Model-C stellarator, demonstrate the validity of the theoretical conclusion. (auth)

36737 A REVIEW OF THE NONLINEAR THEORY OF PLASMA OSCILLATIONS. Einaudi, F. (Univ. of Toronto); Sudan, R. N. Plasma Phys., 11: 359-89(May 1969).

A coherent review of various aspects of nonlinear longitudinal plasma oscillations is presented. The two cases of a single mode and of a continuum of modes are treated separately. In the monochromatic case, the important role of resonant particles is discussed. It is shown that secular terms arise when the Vlasov and Poisson equations are solved by a regular perturbation method in powers of the electric field. The application of singular perturbation methods to remove secularities is treated. In the second case, the quasi-linear theory is reviewed and Dupree's extension is also discussed. After describing Al'tshul and Karpman's method of summing the principal secular terms to all orders, the kinetic equation of waves, wave-particle interactions and resonant wave interactions are discussed. The plasma echo phenomenon is also described briefly. (auth) (UK)

36738 EXACT SOLUTIONS FOR TRANSVERSE ELECTROMAGNETIC-WAVE PROPAGATION IN A CYLINDRICALLY STRATIFIED AXIALLY MAGNETIZED PLASMA. Westcott, B. S. (Univ. of Southampton, Eng.). Proc. Cambridge Phil. Soc., 66: 129-43(July 1969).

The equations describing transverse propagation of electromagnetic waves in a cylindrically stratified plasma, in which a static magnetic field is imposed parallel to the axis of cylindrical symmetry, are examined. A systematic method developed previously for isotropic media is adapted to yield generalized profiles relating to the plasma properties. These profiles are capable of producing exact solutions for the field distribution in terms of standard transcendental functions. Previously known profiles appear as special cases of the analysis. (auth) (UK)

36739 PROPAGATION OF TE WAVE WITH A LARGE AMPLITUDE ALONG A PLASMA LAYER. Demchenko, V. V.; Dolgopolov, V. V. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 504-8(1969). (In Russian).

Propagation of TE waves along a plane parallel plasma layer lying between two perfectly conducting plates is considered. The density distribution of the plasma-layer thickness is investigated. The expressions are obtained for the fields and the dispersion equation. (auth)

36740 ON NONLINEAR EFFECTS ARISING FROM SCATTERING OF ELECTROMAGNETIC WAVES IN A BOUNDED PLASMA. Yakimenko, I. P. (Inst. of Radioelectronics, Kharkov). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 495-503(1969). (In Russian).

Nonlinear boundary problems for an isotropic plasma are considered in the given field approximation. Two nonlinear effects are described in the frame of the theory of scattering on electromagnetic fluctuations in a bounded plasma: nonthermal radiation on combinational frequencies and scattering on induced fluctuations of an electron charge which arise from the interaction between transverse waves in a plasma cylinder of an arbitrary radius. (auth)

36741 STATIONARY ION-ACOUSTIC WAVES IN A BEAM-PLASMA SYSTEM. Fainshtein, S. M. (Gorky State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 547-51(1969). (In Russian).

The problem of steady-state oscillations in an active nonlinear system, i. e., a nonisothermal plasma pierced by a flux of charged particles, is treated by means of quasi-hydrodynamic equations. It is shown that, under certain conditions, an auto-oscillating solution for such a system is possible. (auth)

36742 HYDROMAGNETIC COUPLING OSCILLATIONS AND DRIFT INSTABILITIES IN NONUNIFORM, COLLISIONLESS PLASMAS. Tamao, Tsutomu (Tokyo Univ.). Phys. Fluids, 12: 1458-70(July 1969).

The thermal effects of resonant coupling hydromagnetic oscillations in inhomogeneous, finite-β plasmas, are studied. There are two thermal effects for such oscillations, the thermal phase mixing due to wave-particle resonance interactions and the drift effect arising from plasma inhomogeneities. Applying the drift kinetic approximation, the basic equations for the coupling modes between the Alfvén and magnetosonic waves in a nonuniform, collisionless plasma are obtained. For the plasma with $\beta \simeq m_e/m_i$, ratio of electron to ion mass, it is shown that the electron thermal dissipation of hydromagnetic oscillations with $\omega/k_{||} \simeq V_A$ is most effective within the resonance coupling regions which appear in the cold plasma limit. This dissipation is very large as compared with the same dissipation process in the homogeneous plasma. On the other hand, if the hot plasma with $\beta \sim 1$ is considered, attenuation of hydromagnetic waves due to ion-wave interaction becomes important. It will be an important process for ion heating, and the relevant equations are also derived. Next, drift instabilities in the long-wavelength limit are discussed for the most general case, including the density, temperature, and magnetic field gradients, as well as the ion Larmor radius effect. In particular, the slow mode of drift waves is unstable when $T_e' B_0' > 0$ or $T_e' N_0' < 0$, where prime means the spatial derivative in the radial direction. Finally, discussions of application to the magnetospheric plasma phenomena, which will be associated with inhomogeneities of the thermal constituents, are qualitatively given. (auth)

36743 PLASMA WAVE ECHO EXCITED BY TWO CYCLOTRON WAVES. Kamimura, Tetsuo; Hasegawa, Akira (Osaka Univ.). Phys. Fluids, 12: 1480-2(July 1969).

It is shown that two cyclotron waves excited with a time interval τ between them, in a collisionless plasma, lead to a longitudinal plasma wave echo. The echo appears at the same time as in the case of excitation by two plasma waves. (auth)

36744 OBLIQUE REFLECTION OF A PLANE IMPULSIVE ELECTROMAGNETIC WAVE FROM A PLASMA HALF-SPACE. Wait, James R. (Univ. of Colorado, Boulder). Phys. Fluids, 12: 1521-2(July 1969).

Using the known steady-state solution, the transient response of the reflected wave for an incident wave of impulse wave shape is derived. It is indicated that the response "rings" at the plasma frequency divided by the cosine of the angle of incidence. (auth)

36745 PROPAGATION OF TWO ION WAVES. Ohnuma, Toshiro; Hatta, Yoshisuke (Tohoku Univ., Sendai). Phys. Fluids, 12: 1524-5(July 1969).

Wave-wave coupling among three or four ion wave modes is treated. (auth)

36746 TEMPORAL PLASMA ECHOES. Baker, John C.; Oldham, William J. B. Jr. (Manned Spacecraft Center, Houston, Texas). Phys. Fluids, 12: 1525-6(July 1969).

Results are given from a computer experiment conducted on a 9000-particle plasma to test the theoretical prediction of temporal echoes. The second-order echo is found at the time and wavenumber as predicted by the theory. (auth)

36747 TRANSIENT RADIATION IN A PLANE STRATIFIED DISPERSIVE MEDIUM. II. EXPONENTIAL PROFILE, PLASMA SLAB, AND PLASMA GAP. Otto, Edward (Cornell Univ., Ithaca, N. Y.); Shmoys, Jerry. Can J. Phys., 47: 1435-46(July 15, 1969).

In a previous paper by the authors, a similarity principle was derived for a class of transient diffraction problems in cold, lossless, isotropic, plane stratified plasmas. In this paper, the similarity principle is utilized to obtain exact closed-form solutions to three specific problems; the problems of an impulsive point mag-

netic dipole (the current density is a delta function in space and time) in the presence of (1) a continuously varying plane stratified plasma with an exponential electron density profile, (2) a grounded plasma slab, and (3) a grounded plasma gap. In the case of the exponential electron density profile, the solution to the problem suggests a new type of approximation to cases where the profile is slowly varying but otherwise arbitrary. In the case of the slab and gap problems an interpretation will be given in terms of multiply reflected rays within the slab. The gap problem is particularly interesting because, if the impulsive time dependence of the source were replaced by a harmonic time dependence, this problem would be distinguished by the presence of a surface wave. Thus an examination of the gap problem serves to illustrate the role played by the surface wave in the transient case. (auth) (CANADA)

36748 PARAMETRIC EXCITATION AND QUENCHING OF LONGITUDINAL PLASMA WAVES. Hasegawa, Akira (Bell Telephone Labs., Inc., Murray Hill, N. J.); Davidson, R.; Goldman, R. Appl. Phys. Lett., 14: 325-7(May 15, 1969).

General conditions of parametric excitation and parametric quenching of the longitudinal plasma waves involving negative energy wave(s) are derived by expressing the growth rate of these waves in terms of quantities involving only the linear plasma conductivities and the amplitude of density modulation by the pump. (auth)

36749 LOW-FREQUENCY WAVES IN A D-C PLASMA DISCHARGE. Zaitsev, A. A.; Shvilkin, B. N.; Makhrov, V. F. Radiotekh. Elektron., 14: 728-30(Apr. 1969). (In Russian).

The characteristics of propagation of low-frequency waves in the positive column of a plasma were investigated experimentally at low pressures of 5×10^{-2} to 3×10^{-1} mm Hg std in hydrogen. The results show that at frequencies between 30 and 400 kilocycles/sec, self-excited and artificially excited waves are propagated. The discharge took place in a cylindrical glass tube of 100 cm length at diameters of 2.5, 3.0 and 5.2 cm between an oxide cathode and a hollow anode of cylindrical shape. The discharge current was 0.05 to 0.3 A. Artificially stationary waves were excited by introducing a periodic perturbation into the plasma from the outside. At gas pressures above 7×10^{-2} mm Hg there existed stationary strata in the positive column. Under these conditions waves of two different types are propagated in the plasma depending on the pressure. One type of wave is caused by strata oscillations. The other type of wave can be considered as ion-acoustic. (TTT)

36750 OBSERVATION OF DRIFT WAVES IN A RADIO-FREQUENCY PLASMA. Lisitano, G. (Institut fuer Plasmaphysik, Garching, Ger.); Bernabei, S.; Sindoni, E. Nuovo Cim., Lett., 2: 109-12(July 21, 1969).

The dependence of the drift-wave frequency on the ion mass number is studied for hydrogen, helium, argon, and xenon. The discharge was produced in electron cyclotron resonance conditions by means of an L coil of 3-cm internal diameter placed at one end of a magnetic mirror. The self-sustained drift waves were studied in conditions of density fluctuation. (M.O.W.)

36751 QUANTUM THEORY OF THE PLASMA-RADIATION INTERACTION. I. Peyraud, J. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 30: 307-24(Apr. 1969). (In French).

The quantum interaction between a plasma and the radiation field was studied by means of a special cluster expansion of the products of quantum annihilation and creation operators for particles and photons. The formalism and its application to the scattering processes are presented. (auth)

36752 RELATIVISTIC INFLUENCE ON THE DIELECTRIC BEHAVIOUR OF A PLASMA NEAR CYCLOTRON RESONANCE. Schram, D. C. (EURATOM-FOM, Jutphaas, Netherlands). Physica, 40: 422-34(Dec. 30, 1968).

The interaction between an electron plasma and a transverse electromagnetic wave propagating along a stationary magnetic field exhibits a resonance if the Doppler-shifted frequency equals the electron cyclotron frequency. The interaction will become nonlinear if the electric field of the wave is so large that the variation of the axial velocity, first-order Doppler-effect and the relativistic mass change, second-order Doppler-effect, have to be taken into account. These effects are of comparable importance and will determine the permittivity of an electron plasma near cyclotron resonance in case collisions and inhomogeneities of the fields and of the density can be neglected. Here, a method is presented by which the permittivity can be calculated for given values of the wave amplitude, of the density, of the magnetic field strength, and of the applied frequency. (auth)

36753 LOW-FREQUENCY RESONANCES AND AVERAGED FIELD POTENTIAL IN A NONISOTHERMAL PLASMA. Aleksandrov, A. F.; Kuzovnikov, A. A.; Nikolov, N.; Rukhadze, A. A. (Moscow State Univ.). Nucl. Fusion, 9: 137-41(June 1969).

The interaction of a low-frequency electromagnetic field with a plane nonisothermal plasma layer when the field frequency is less than the ion Langmuir frequency but greater than the collision frequency of the ions was investigated. The plasma density and velocity are determined to second order with respect to the applied field; the electric field in the plasma itself is also determined and the frequencies of the resonance interaction of the field with the plasma layer are found. By averaging the equation of plasma motion, the authors find the steady-state density distribution in the plasma layer and obtain expressions for the averaged force and potential of a low-frequency field in a nonisothermal plasma under conditions of strong spatial dispersion. The possibility of observing the self-focusing of ion sound in a plasma under the influence of an averaged force and density modulation in a plasma layer located in the variable field produced by a plane capacitor are discussed. (auth)

36754 LAMINAR STRUCTURE OF NONLINEAR WAVES IN A MULTICOMPONENT COLLISIONLESS PLASMA. Pataraya, A. D. (Inst. of Physics, Tbilisi, USSR). Nucl. Fusion, 9: 121-7(June 1969).

Nonlinear waves propagating at an angle to the external magnetic field in a multicomponent, completely ionized, quasi-neutral plasma are considered. Collisions between plasma particles are not taken into account. For waves propagating across the magnetic field, thermal effects are taken into account by means of Vlasov kinetic equations. Dispersion effects due to deviation of the dispersion law $\omega = \omega(k)$ from a linear one were studied. An analytical expression is obtained for the profile of an isolated wave of low amplitude and it is found that, depending on the angle between the magnetic field and the velocity of wave propagation, the wave can be a nonlinear compression or rarefaction wave. The necessary conditions limiting changes in the Mach number are established. The fine structure of the solitary wave is investigated for a three-component plasma, allowance being made for effects associated with electron inertia. It is found that the depression in the solitary compression wave appears only when the ions of both sorts are positively charged. The critical Mach number (M_c) and magnetic field strength (h_c) values are obtained. For $M > M_c$ there is a depression in the solitary compression wave. (auth)

Shielding

Refer also to abstracts 35746, 35830, 36811, 37043, 37058, and 37662.

36755 (AD-686691) A STUDY OF THE RELATIONSHIP BETWEEN THE NEUTRON ABSORBED DOSES IN AN UNDERGROUND STRUCTURE AND IN A SEMI-INFINITE MEDIUM. Report on Nuclear Radiation Shielding Studies. Roussin, R. W. (Illinois Univ., Urbana). Feb. 1969. Contract DA-49-146-XZ-319. 107p. (NRSS-11; DASA-2219). CFSTI.

The penetration of neutrons from nuclear weapons into underground structures is studied in idealized fashion. Neutrons from a burst about a kilometer directly overhead are considered incident upon the surface of a semi-infinite medium of concrete-like properties. Calculations of two general cases are made: (1) the absorbed dose within the unperturbed medium at certain depths; and (2) the absorbed doses at various locations in a cylindrical cavity in the medium. Results are expressed as ratios of the second case to the first, thus treating the cavity as a perturbing influence upon the absorbed dose field in the semi-infinite medium. The computer code 05R is adapted to this study. Results indicate that the cavity perturbation ratios are always less than unity, implying the possible use of simple semi-infinite medium calculations as conservative estimates of radiation penetration into underground structures. Generalizations to more practical cases are made. A simple diffusion model approach to calculation of the ratios is shown to be adequate for cavities representing normal rooms, but not vertically long and narrow (silo-like) cavities. (auth) (USGRDR)

36756 (AD-822964) EXPERIMENTAL VERIFICATION OF NEUTRON TRANSPORT CALCULATIONS IN LITHIUM HYDRIDE. Technical Report, December 13, 1966-June 13, 1967. Profio, A. E.; Cerbone, R. J.; Huffman, D. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1967. Contract F29601-67-C-0031. 108p. (GA-8121; AFWL-TR-67-72). CFSTI.

Measurements of the high-energy neutron angular flux spectrum in a sphere of natural lithium hydride were made by the time-of-flight method. The work is a continuation of the comparison of accurate, detailed, high-resolution measurements, formerly made

in CH_2, with DTF-4 discrete ordinates and 05R Monte Carlo calculations. The CH_2 sphere was recalculated with 05R, using an angular resolution corresponding to experiment, and good agreement was obtained. The exponential transform was investigated to reduce variance at a fewer number of neutron histories. The optimum biasing parameter was found for the uncollided flux, but the exponential transform as applied to the CH_2 sphere problem did not result in large reductions of variance. The lithium hydride sphere was calculated with DTF-IV, using different quadrature sets and cross sections. Agreement with experiment is not as good as for CH_2, and further investigations are recommended. (auth) (USGRDR)

36757 GAMMA RADIATION FROM C, Al, Ti, Nb, AND U THICK TARGETS IN REACTIONS INDUCED BY 10.5-MeV PROTONS. Daruga, V. K.; Dvukhsherstnov, V. A.; Dulin, V. A.; Matusevich, E. S.; Omarov, S. S.; Prokhorov, S. S. At. Energ. (USSR), 26: 80(Jan. 1969). (In Russian).

Gamma radiation doses from targets ~1 g/cm² thick bombarded by 10.5-MeV protons were measured. A stilbene scintillation crystal placed at an angle of 90° to the incident proton beam and an electronic circuit designed to distinguish between gamma radiation and recoil protons were used for the measurements. The measured doses ($\times 10^{-18}$ rad m²/proton) were 16 ± 1.6 for C, 13 ± 1.2 for Al, 11 ± 1.0 for Ti, 8.2 ± 0.8 for Nb, and 1.7 ± 0.2 for U. These results were used to calculate the energy carried away by the gamma radiation from the expression $\epsilon = (D4\pi R^2)/(\Sigma_a W)$, where D is the dose, R is the distance from target to detector, Σ_a is the cross section for energy absorption by the crystal, and W is the probability for inelastic nuclear interactions of the protons with the target. The values obtained (in MeV) were 2.5 for Al, 3.5 for Ti, 4.5 for Nb, and 3.5 for U. (A.G.W.)

36758 NEW SOLUTIONS TO THE NEUTRON TRANSPORT EQUATION FOR HETEROGENEOUS SYSTEMS. Boffi, V. C.; Molinari, V. G.; Premuda, F.; Trombetti, T. (CNEN, Bologna). Trans. Amer. Nucl. Soc., 12: 157-8(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36759 GREEN'S FUNCTIONS FOR MULTIDIMENSIONAL NEUTRON TRANSPORT IN A SLAB. Garrettson, G. A.; Leonard, A. (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 12: 159-60(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36760 TRANSPORT SOLUTION OF A QUARTER-SPACE PROBLEM. Schreiner, Sheldon I. (Univ. of Washington, Seattle); McCormick, N. J.; Gibbs, Alan G. Trans. Amer. Nucl. Soc., 12: 160-1(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36761 TECHNIQUES FOR THE DEVELOPMENT OF A SHIELDING CAPABILITY. Reinhardt, Gough C. (Defense Atomic Support Agency, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 365(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36762 ANALYSIS OF SHIP SHIELDING REQUIREMENTS. Ksanda, C. F. (Naval Radiological Defense Lab., San Francisco, Calif.). Trans. Amer. Nucl. Soc., 12: 365-6(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36763 ANALYSIS OF INITIAL RADIATION PROTECTION ABOARD SHIP. French, R. L.; Newell, J. M. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 12: 366(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36764 EFFECT OF THE GROUND ON THE TRANSPORT OF NEUTRONS AND SECONDARY GAMMA RAYS IN THE ATMOSPHERE. Straker, E. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 367-8(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36765 USE OF THE METHOD OF DISCRETE ORDINATES FOR PHOTON TRANSPORT CALCULATIONS. Renken, James H. (Sandia Labs., Albuquerque, N. Mex.). Trans. Amer. Nucl. Soc., 12: 370(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36766 USE OF TWO-DIMENSIONAL DISCRETE ORDINATES CALCULATIONS TO EVALUATE STREAMING EFFECTS IN ANNULAR DUCTS. Mynatt, F. R. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 370-1(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36767 SLOWING DOWN MODEL FOR NEUTRON TRANSPORT IN AIR. Cramer, S. N. (Univ. of Tennessee, Knoxville); Stevens, P. N.; Cain, V. R.; Straker, E. A. Trans. Amer. Nucl. Soc., 12: 371-2(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36768 X-RAY TRANSPORT IN A SPHERICAL-SHELL ATMOSPHERE. Marshall, J. D.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 12: 372-3(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36769 ENERGY DEPOSITION RATE AND COMPTON ELECTRON CURRENT IN HOMOGENEOUS AIR DUE TO A POINT SOURCE OF GAMMA RAYS. Hale, Clovis R. (Air Force Weapons Lab., Kirtland AFB, N. Mex.); Bridgman, Charles J. Trans. Amer. Nucl. Soc., 12: 373(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36770 FAR-FIELD ESTIMATES IN STRUCTURE SHIELDING EXPERIMENTS. Kaplan, Arthur L. (Technical Operations, Inc., Framingham, Mass.). Trans. Amer. Nucl. Soc., 12: 373-4(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36771 GAMMA-RAY DOSE RATES IN A SLAB PHANTOM. Claiborne, H. C.; Trubey, D. K. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 383-4(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36772 TRANSVERSE SHIELDING CALCULATIONS FOR HIGH-ENERGY PHOTON BEAMS. O'Brien, Keran (Atomic Energy Commission, New York). Trans. Amer. Nucl. Soc., 12: 391-2(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36773 ELECTRON ENERGY DEPOSITION, COMPUTATIONS WITH AN EMPIRICAL ANALYTIC FORM. Liley, Bobby (North American Rockwell Corp., Downey, Calif.). Trans. Amer. Nucl. Soc., 12: 392-3(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36774 ENERGY AND ANGULAR DISTRIBUTION OF ELECTRONS TRANSMITTED THROUGH TIN. Lonergan, J. A.; Costello, D. G. (Gulf General Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 393-4(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36775 PENETRATION OF ^{137}Cs GAMMA RAYS THROUGH ALUMINUM SLABS. Bennett, Burton G.; Beck, Harold L. (Atomic Energy Commission, New York). Trans. Amer. Nucl. Soc., 12: 395-6(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36776 NEUTRON-INDUCED ELECTRICAL SOURCES. Stevens, C. A. (Gulf General Atomics, San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 368-9(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36777 TRANSPORT CALCULATIONS USING TRANSMISSION AND REFLECTION MATRICES. Hoecker, K. H.; Maute, A. H. (Univ. of Stuttgart). Trans. Amer. Nucl. Soc., 12: 396-7(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36778 APPLICATIONS OF THE TRANSMISSION MATRIX METHOD TO GAMMA RADIATION TRANSPORT. Boulette, E. T. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 397-8(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36779 NEUTRON AND GAMMA-RAY SPECTRA IN LITHIUM HYDRIDE-TUNGSTEN SHIELDS. Profio, A. E.; Cerbone, R. J. (Gulf General Atomics, San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 399(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36780 NEUTRON AND GAMMA-RAY SPECTRA IN A SPHERICAL IRON ASSEMBLY. Cerbone, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 399-400(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36781 ONE-DIMENSIONAL TIME-DEPENDENT DISCRETE ORDINATES. Engle, W. W. Jr. (Union Carbide Corp., Oak Ridge, Tenn.); Mynatt, F. R.; Booth, R. S. Trans. Amer. Nucl. Soc., 12: 400-1(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36782 LEAKAGE TRACING FROM BOUNDARIES OF LOW-ORDER S_N SOLUTIONS. Lindstrom, D. G.; Wilcox, A. D. (Aerojet-General Corp., Sacramento, Calif.). Trans. Amer. Nucl. Soc., 12: 401-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36783 NEW NEUTRON MOMENTS PROGRAM AND APPLICATIONS TO BeO. Weisbin, Charles R.; Lidofsky, Leon J.; Goldstein, Herbert (Columbia Univ., New York). Trans. Amer. Nucl. Soc., 12: 402-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36784 NEUTRON ADJOINT MONTE CARLO CALCULATIONS. Cohen, M. O. (Mathematical Applications Group, Inc., White Plains, N. Y.). Trans. Amer. Nucl. Soc., 12: 403(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36785 MONTE CARLO CALCULATIONS OF A HEMISPHERICAL DUCT NEUTRON STREAMING EXPERIMENT. Clemons, L.; Wrights, G. N.; Shook, D. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 12: 404(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Solid-State Physics

Refer to abstracts 36078, 36817, and 37135.

Radiation Effects

Refer also to abstracts 35229, 35480, 35516, 35570, 35573, 35574, and 36799.

36786 (AEC-tr-6869/7, pp 1148-52) ABSORPTION AND PHOTOCONDUCTIVITY OF NEUTRON-IRRADIATED CUPROUS OXIDE. Lisitsa, M. P.; Kholodar, G. A. Translated from Ukr. Fiz. Zh., 12: 1173-7(July 1967).

Two batches of specimens prepared from multiply refined copper were oxidized at 1223°K for 11 and 37 hours, respectively; both single-crystal and polycrystal specimens were used in each batch, and impurity concentration before oxidation did not exceed 0.002%. Photoconductivity and absorption measurements were made both before and after neutron irradiation (activity of 4.7×10^6 n/sec, average energy 4.5 MeV, time 5 days). Exposure to neutrons markedly distorted the photoresponse spectrum, the photoresponse curve showing a number of peaks whose position changed from one specimen to another; the spectra of most exposed specimens, however, showed distinct peaks at 1.4, 1.85, and 2.25 μ. No absorption maxima were observed between $1 < \lambda < 3\ \mu$ in unirradiated specimens; only after exposure and sufficiently low temperature do the absorption spectra acquire distinct structure. The features of photoresponse and absorption are clearly related either to departure from stoichiometric composition or radiation damage. In either case, these are obvious impurity effects, levels of which can be identified as lattice defects (apparently mainly copper vacancies). (L.M.T.)

36787 (AEC-tr-6869/7, pp 1181-3) ROENTGENOLUMINESCENCE OF THE $CaSO_4$–Mn PHOSPHOR AND ITS STORED ENERGY. Ivanii, G. M. Translated from Ukr. Fiz. Zh., 12: (July 1967).

Roentgenoluminescence, afterglow, and thermoluminescence of powdered $CaSO_4$: Mn (4 mole %) phosphor for various radiation intensities and temperatures are considered. The phosphor was prepared from a $CaSO_4$ and $MnSO_4$ mixture by sintering at 900 to 1000°C. Commercial $CaSO_4$ was used, with Ba, Fe, Si, Mg, and Mn impurities according to spectroscopic analysis. Roentgenoluminescence, afterglow, and thermoluminescence spectra of this phosphor are all identical, comprising a single emission band $\lambda_m = 500\ m\mu$, which remains unchanged regardless of exposure and temperature conditions. These spectra are, furthermore, identical to the thermoluminescence spectrum of $CaSO_4$: Mn single crystals (Arkhangel'skaya and Razumova, Opt. Spektrosk., 20: 299(1963)). It was also found that $CaSO_4$: Mn has an enormous capacity for light storage. (TSS)

36788 (SC-DC-69-1670) ELECTRICAL STUDIES OF LOW TEMPERATURE NEUTRON AND ELECTRON IRRADIATED EPITAXIAL n-TYPE GaAs. Stein, H. J. (Sandia Labs., Albuquerque, N. Mex.). [1969]. 29p. (CONF-690704-5). Dep. CFSTI.

From Conference on Nuclear and Space Radiation Effects, University Park, Pa.

Electron- and neutron-produced defects in epitaxially grown n-type ($n \simeq 2 \times 10^{15}\ cm^{-3}$) GaAs were investigated, using Hall effect and electrical conductivity measurements. Electron irradiation (2 MeV) at 80°K decreases both the carrier concentration and the mobility. Below room temperature annealing of electrically active defects is observed near 250°K in agreement with thermal conductivity and length-change measurements of electron-produced defect annealing in n-type bulk-grown GaAs. One electron irradiation produced a carrier removal rate of 2.9 cm^{-1} at 80°K, an observed electronic energy level at $\sim E_c - 0.14$ eV, and a major annealing recovery stage near 500°K, all in reasonable accord with previous results from bulk-grown n-type GaAs. Neutron irradiation (approximately fission spectrum) at 76°K also decreases both the carrier concentration and the mobility in n-type epitaxial GaAs. A light sensitivity of the carrier concentration and mobility is observed in GaAs after neutron irradiation. By analogy to Si and because disordered regions have been observed in electron microscope measurements on neutron-irradiated GaAs, the neutron-produced light sensitivity is ascribed to disordered regions. In contrast with electron-produced defects in GaAs, neutron-produced defects in the epitaxial layer exhibit only small and diffuse annealing throughout the 76 to 600°K temperature range investigated. The mobility degradation after 400°K annealing is measurement-temperature-dependent and decreases with increasing measurement temperature between 76 and 300°K. The carrier removal rate, on the other hand, is nearly independent of measurement temperature and is 3.0 cm^{-1} at 296°K. This carrier removal rate is in reasonable agreement with previous results on bulk-grown n-type GaAs irradiated at ~375°K. Gunn effect oscillators are critically dependent upon carrier concentration, therefore carrier removal is expected to be the dominant failure mechanism for these devices under irradiation. (auth)

36789 (SC-DC-69-1700) THERMAL AND INJECTION ANNEALING OF NEUTRON-IRRADIATED P-TYPE SILICON BETWEEN 76°K AND 300°K. Barnes, C. E. (Sandia Labs., Albuquerque, N. Mex.). [1969]. 13p. (CONF-690704-1). Dep. CFSTI.

From Conference on Nuclear and Space Radiation Effects, University Park, Pa.

Measurements of minority carrier lifetime damage constant and divacancy growth following neutron irradiation at 76°K have been used to characterize further the annealing of neutron damage in silicon below 300°K. It has been shown that electron injection into p-type silicon at 76°K causes recovery of the neutron induced defect clusters with the simultaneous appearance of divacancies. Isochronal annealing curves of damage constant taken with and without prior injection at 76°K illustrate the nature of cluster annealing below 300°K. The thermal annealing results are shown to agree with previous annealing measurements of the carrier removal rate. (auth)

36790 (SC-DC-69-1703) MINORITY CARRIER RECOMBINATION IN NEUTRON IRRADIATED SILICON. Gregory, B. L. (Sandia Labs., Albuquerque, N. Mex.). [1969]. 42p. (CONF-690704-2). Dep. CFSTI.

From Conference on Nuclear and Space Radiation Effects, University Park, Pa.

Measurements that provide extensive data on the resistivity, temperature, and injection level dependences of the minority carrier lifetime in neutron-irradiated p- and n-type silicon are reported. The lifetime damage constants are observed to be strongly dependent on the injected minority carrier density, in both conductivity types, over the temperature range from 76 to 300°K. The low-injection-level damage constants were measured and found to be strongly dependent on material resis-

tivity in p-type silicon, but only slightly dependent on resistivity in n-type silicon. The results of the experimental studies are compared to the predictions of two alternate models for recombination at defect clusters. It is concluded from these comparisons that the defect clusters that dominate the minority carrier lifetime are approximately 250 Å in radius, and each contains a relatively small number of deep defects (30 to 40). The defects are individually characterized by a deep donor level near $E_v + 0.35$ eV and a deep acceptor level near $E_c - 0.50$ eV. Since these levels correspond closely to known energy levels of the silicon divacancy, it is suggested that the divacancy is the dominant recombination center within the defect clusters. (auth)

36791 ANNEALING OF ELECTRON-IRRADIATED CdS. Kitagawa, Michiharu; Yoshida, Toshio. Annu. Rep. Radiat. Center Osaka Prefect., 9: 45-8(1968).

Electron-irradiation and isochronal annealing effects on carrier concentration of the high-conductive n-type CdS crystal irradiated with 10-MeV electrons were investigated. The irradiation was carried out at about 150°K. Total irradiation dose was 1.1×10^{17} electrons/cm^2. From the temperature dependences of carrier concentration, activation energies are estimated to be 0.010 eV and 0.019 eV before and after irradiation, respectively. Analysis of the data leads to the conclusion that a large number of acceptors produced by irradiation partially compensate the concentration of donors and that the donor level is located at 0.019 eV below the bottom of the conduction band. The concentration of the produced acceptors is estimated to be approximately 1×10^{17} cm^{-3}. (auth)

36792 OPTICAL ABSORPTION IN ZnS CRYSTALS IRRADIATED WITH NEUTRONS AND ELECTRONS. Yoshida, Toshio; Fujino, Takahiro; Oka, Takashi; Shono, Yoshihiko. Annu. Rep. Radiat. Center Osaka Prefect., 9: 40-4(1968).

Optical absorption bands introduced by irradiation with fast neutrons or high-energy electrons in ZnS single crystals were investigated. The absorption near the intrinsic absorption edge in electron-irradiated crystals is located more narrowly than that in neutron-irradiated crystals. The absorption band around 430 mμ found in electron-irradiated crystals is broader than that in neutron-irradiated crystals. The absorption band having the peak around 540 mμ is found in neutron-irradiated or electron-irradiated crystals. As the temperature decreases, the 540-mμ band increases in intensity, the peak shifts toward longer wavelength side, and the half-width decreases. The half-width is 0.37 eV at liquid nitrogen temperature and 0.31 eV at liquid helium temperature. The 540-mμ band is Gaussian in shape at least at low temperatures. (auth)

36793 ESR OF ELECTRON IRRADIATED ZnS SINGLE CRYSTAL. Shono, Yoshihiko; Yoshida, Toshio. Annu. Rep. Radiat. Center Osaka Prefect., 9: 49-51(1968).

Several ESR signals were observed in ZnS single crystal irradiated with 5-MeV electrons. Their g values were 2.0545, 2.0472, 2.0028, and 1.9896, when the static magnetic field was along [111] crystal axis. Especially, the experimental results for the signal at g = 2.0028 are discussed in detail. Some results can be explained by the model that the ESR signal arises from the electron trapped around the S vacancy, but some remain unexplainable. A band model is presented by which the photosensitivities of the signals at g = 2.0028 and due to Fe^{3+} can be explained. (auth)

Physical Properties

Refer also to abstract 36227.

36794 THERMAL CONDUCTIVITY AND LORENTZ NUMBER OF GADOLINIUM AT LOW TEMPERATURES (0.4 TO 4.2°K). Ratnalingam, R.; Sousa, J. B. (Clarendon Lab., Oxford). Phys. Lett., 29A: 367-8(June 16, 1969).

The thermal conductivity of gadolinium, measured between 0.4 and 4.2°K, can be separated into a linear (T) and a quadratic (T^2) contribution. The Lorentz number, as estimated from the linear term, agrees well with the theoretical value. Tentative suggestions are made for the T^2 contribution. (auth)

36795 TRANSITION METAL MOMENT COLLAPSE IN $Gd(Co_{1-x}Ni_x)_2$. Taylor, K. N. R. (Univ. of Durham, Eng.). Phys. Lett., 29A: 372-3(June 16, 1969).

The magnitude of the transition metal moment in the series of compounds $Gd(Co_{1-x}Ni_x)_2$ was derived from the observed molecular moments. Its variation with x shows a rapid decrease in the vicinity of x = 0.5. (auth)

36796 MEASUREMENT OF EXCHANGE INTEGRALS BY NEUTRON SCATTERING. Murthy, N. S. Satya; Rao, L. Madhav (Bhabha Atomic Research Centre, Trombay, India). Proc. Nucl. Phys. Solid State Phys. Symp., 1968, Bombay, 177-214(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.1).

The measured exchange integrals of crystals yield information on the exchange interactions and thus the magnetic properties of crystals. The measurement of exchange integrals by neutron scattering in the spin wave and paramagnetic scattering regions is discussed and compared with other methods. (J.W.R.)

36797 SPIN WAVES NEAR THE CURIE POINT. Drabkin, G. M.; Okorokov, A. I.; Zabidarov, E. I.; Kasman, Ya. A. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 9: 204-7(Mar. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 347-52(Mar. 20, 1969).

In a previous study on critical scattering of neutrons in nickel (Zh. Eksp. Teor. Fiz., 56: 479(1969)) the authors observed flat maxima at $T < T_c$. With increasing angle of observation, these maxima shift toward higher temperatures (maxima called scattering of type II in above reference). In scattering in iron, similar maxima were observed by Jacrot et al. (Inelastic Scattering of Neutrons in Solids and Liquids, IAEA, Vienna, 1963, Vol. II, p.317). In this paper it is shown that these maxima are due to scattering of neutrons by spin waves. (TSS)

36798 OPTICAL PROPERTIES OF IONS IN CRYSTALS. Conference held at Johns Hopkins University, Baltimore, Maryland, September 12-14, 1966. Crosswhite, H. M.; Moos, H. W. (eds.). New York, John Wiley and Sons, Inc., 1967. 566p. $18.50. (CONF-660929).

Most of the papers presented at the subject conference are included. Emphasis is on underlying principles rather than device applications. Organized according to subject, the papers give an insight into several trends in the field: the moving away from phenomenological crystal field models to more fundamental approaches involving covalent bonding; the interest in cooperative phenomena; and the interest in the interaction of an ion with a moving lattice, and directly related to this, energy transfer. The 40 papers are organized under these headings: (1) rare-earth energy level structure and transition probabilities; (2) energy levels and excited state effects in transition metal ions; (3) cooperative effects; (4) vibronics and infrared studies; and (5) energy transfer. (TSS)

36799 PROPERTIES OF EPITAXIALLY GROWN SILVER AND GOLD FILMS AND THE INFLUENCE OF ALPHA IRRADIATION. Van Itterbeek, A.; Coppens, R.; Hendriks-van Itterbeek, W. (Instituut voor Lage Temperaturen en Technische Fysika, Leuven, Belgium). Physica, 40: 77-90(Oct. 31, 1968).

The temperature dependence of the electrical resistance of polycrystalline and epitaxially grown silver and gold films, deposited on freshly cleaved NaCl substrates, was measured between 295 and 4.2°K. The polycrystalline layers were obtained by condensing on glass substrates and also on nonfreshly cleaved NaCl substrates. A pressure lower than 5×10^{-7} torr was obtained during evaporation using a diffusion pump of the Venema-type. The thickness of the films ranged between 450 and 1050 Å; it was determined by the Tolansky method. A comparison of the results with those reported by Chopra for films condensed on mica is given. The influence of alpha irradiation on the structural properties as well as on the electrical resistance of the silver and gold films was also studied. The latter are less sensitive to alpha irradiation than the former. The structure of the films was determined using an electron microscope as well as electron diffraction. (auth)

36800 RARE-EARTH ELEMENTS AND HIGH PRESSURES. Fisk, Zachary; Matthias, Bernd T. (Univ. of California, San Diego, La Jolla). Science, 165: 279-80(July 18, 1969).

The behavior of solid solutions of rare earths in ZrB_{12} under the high pressures exerted by the extreme rigidity of the boron lattice was observed. Since ZrB_{12} is superconducting at 6°K, an indication of the effect of this pressure on the magnetic configuration of the dissolved rare-earth atom can be seen in the depression of the ZrB_{12} transition temperature; results show only one pronounced maximum (for praseodymium) recycling close to 13°K/at. %. The magnitude of this maximum points to a virtual bound f-level in Pr very near the Fermi surface; it was felt that Pr in ZrB_{12} would also exhibit a resistance minimum, and experimental verification of this is shown. (L.M.T.)

36801 LATTICE DYNAMICS BY NEUTRON SCATTERING. PART 2. Boffi, S. (Univ., Pavia, Italy); Caglioti, G. Energ. Nucl. (Milan), 16: 517-28(July 1969).

Recent applications of neutron spectrometry to lattice dynamics

of metals, alloys and dielectric materials are reviewed. The problem of the phonon–phonon interaction is briefly examined. (auth)

Moessbauer Effects and NMR

36802 MOESSBAUER SPECTROSCOPIC STUDIES ON IT(IC) DECAY OF ^{119m}Sn IN $K_6Sn_2(C_2O_4)_7.4H_2O$. Sano, Hirotoshi; Kanno, Mitsuko (Ochanomizu Univ., Tokyo). J. Chem. Soc., D, No. 11, 601-2(1969).

The first experimental evidence for the presence of an anomalous charge state in the IT(IC) decay of ^{119m}Sn was found in ^{119m}Sn-labelled $K_6Sn_2(C_2O_4)_7.4H_2O$. (auth) (UK)

36803 CHEMICAL APPLICATIONS OF MOESSBAUER SPECTROSCOPY. Goldanskii, V. I.; Herber, R. H. (eds.). New York, Academic Press Inc., 1968. 713p. $29.00.

The fundamental theory and experimental practice of Moessbauer spectroscopy are surveyed and the applications of this technique in various chemical studies are discussed. Topics covered include: fundamentals of γ resonance spectroscopy; experimental methods; ^{57}Fe in metals, inorganic compounds, and metalloörganic compounds; ^{119m}Sn in inorganic compounds, metals, and metalloörganic compounds; xenon and iodine; Moessbauer effect in rare earths and their compounds; Moessbauer spectroscopy of heavy elements; applications of Moessbauer effect in biology and in nuclear physics; and spin relaxation in solids and aftereffects of nuclear transformations. (M.C.G.)

Theoretical Physics

Refer also to abstracts 35544, 36472, 36855, 36856, 36987, and 36991.

36804 (AD-686820) ON THE INTERACTION BETWEEN MATTER AND RADIATION. Final Report, September 1, 1967–September 30, 1968. Aharonov, Yakir; Petersen, Aage (Yeshiva Univ., New York. Belfer Graduate School of Science). Mar. 26, 1969. Contract F19628-68-C-0053. 18p. (AFCRL-69-136). CFSTI.

It is argued that in describing the interaction between radiation and matter the dynamical account should not be confined to specification of occupation numbers corresponding to the normal modes, but that the specification of the relevant modes is itself a part of the dynamics. This viewpoint is developed by investigation of a model. (auth) (USGRDR)

36805 (NYO-1480-116) FINITE DIFFERENCE METHOD FOR THE SOLUTION OF FREE BOUNDARY PROBLEMS. Bloch, Eugene (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). May 1969. Contract AT(30-1)-1480. 123p. Dep. CFSTI.

The systematic iterative procedure described yields finite difference solutions to steady free-boundary problems of plasma physics and fluid dynamics. By application of the method of steepest descent to minimize certain energy functionals connected with conformal mapping and free-boundary problems, a system of artificially time-dependent equations is produced, which converges to a steady state as the time parameter goes to infinity. The solution is obtained in a parametric form in which the physical plane is the conformal image of a fixed rectangle. The use of a fixed rectangle as the parameter domain enables one to treat effectively the difficulties engendered by the singular behavior of the stream function at the point of separation between the fixed and free boundaries. As a result the scheme can be made convergent to second order in the mesh width h. The method has been applied successfully to the vena contracta and Riabouchinsky models of classical hydrodynamics for both plane and axially symmetric geometries. An accuracy of four significant figures in the calculation of quantities of physical interest can be obtained without difficulty. A plane equilibrium model of plasma physics is also computed. The scheme can be applied to a variety of problems with two independent variables. (auth)

36806 DYNAMICS NEAR EQUILIBRIUM OF SYSTEMS DESCRIBED IN THERMAL HARTREE–FOCK APPROXIMATION. Felderhof, B. U. (Cornell Univ., Ithaca, N. Y.). J. Math. Phys. (N. Y.), 10: 1021-5(June 1969).

The dynamics of systems described in Hartree–Fock approximation is studied near a stationary point of the free energy. It is shown that the second-order free-energy functional is a constant for the linearized self-consistent equation of motion. This leads to the stability criterion derived by Mermin. A simple collision model is constructed and is shown to satisfy the H theorem. It exhibits the effect of critical slowing down. The formalism is shown to be applicable to superconductors. (auth)

36807 NOTES ON NONINTERFERING ELECTRIC AND MAGNETIC FIELDS. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Indian J. Phys., 42: 460-4(Aug. 1968).

It is shown that steady magnetic fields and time-dependent electric fields may exist simultaneously without mutual interference. This happens when the time derivative of the current is irrotational. In this case, Maxwell's equation may be broken up into two sets of equations containing electric and magnetic quantities separately. (auth)

36808 BROKEN SYMMETRY AND GENERALIZED BOSE CONDENSATION IN RESTRICTED GEOMETRIES. Girardeau, M. D. (Univ. of Oregon, Eugene). J. Math. Phys. (N. Y.), 10: 993-8(June 1969).

It is suggested, on the basis of soluble models, that generalized Bose condensation results from a broken symmetry associated with a nonvanishing pairing amplitude with very large low-momentum components, leading to a nonzero "pairing density" ρ_c as well as a nonzero generalized condensate density ρ_c. For systems of interacting bosons it is proved that (1) nonzero ρ_c implies nonzero ρ_c, and (2) $\rho_c = 0$ in one or two dimensions and, more generally, for geometries finite in one dimension and infinite in the other two (films) or finite in two dimensions and infinite in one (pores). It is pointed out that this does not exclude superfluidity in such geometries, but does show the need of a new mechanism to explain it. (auth)

36809 NEW APPROACH FOR SCATTERING BY EVEN-POWER POTENTIALS. Mueller, Harald J. W. (American Univ., Beirut). Ann. Phys. (Leipzig), 21: 122-36(1968).

The radial Schrödinger equation is considered in a more general form and is then transformed into another equation to permit straightforward application of the perturbation formalism used previously by the author. The potential considered is assumed to be expandable in ascending even powers of r. The potential $(\sinh r)^{-2}$ emerges as a special case and is considered separately. For the general case, expansions are obtained for the eigenenergies and eigenfunctions valid in regions of small angular momenta and coupling constants. A simple analytic expression for the S matrix is obtained. Finally, several consequences are discussed. (auth)

36810 ROTATIONS IN QUANTUM MECHANICS. Zak, J. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 29A: 393-4 (June 16, 1969).

A description of an angular coordinate in regular space and phase space is given in the basis of the kq representation. A new quantum-mechanical representation for the phase of a harmonic oscillator is constructed. (auth)

36811 POINT SOURCE GREEN'S FUNCTION FOR NEUTRAL PARTICLE TRANSPORT. Meyer, James F.; Jacobs, Alan M. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc., 12: 161-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

36812 WAVE FUNCTION OF QUANTUM MECHANICS. Selleri, F. (Univ., Bari, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Nuovo Cim., Lett., 1: 908-10(June 11, 1969).

A class of theories with hidden variables is briefly reviewed. In these theories quantum mechanics is regarded not as a final description of phenomena, but as a theory similar to classical thermodynamics which provides relations for statistical averages over unknown (hidden) parameters. The possibility to check experimentally these theories is proposed, adopting the point of view that there must be some sense in which the wave function itself acquires physical reality for any hidden-variable theory. (L.B.S.)

36813 RESOLUTION OF A SYSTEM OF COUPLED SCHROEDINGER EQUATIONS. Hategan, C. (Inst. for Atomic Physics, Bucharest). J. Comput. Phys., 4: 43-53(June 1969).

In order to solve a system of coupled Schroedinger equations, four analytical variants are given, and their range of applicability is discussed. One of these variants is used in the determination of the channel-coupling radial wave functions, the optical-model wave functions and the regular Coulomb function. (auth)

36814 CROSSING OF ENERGY LEVELS. Caspers, W. J. (Univ., Groningen, Netherlands). Physica, 40: 125-38(Oct. 31, 1968).

Level crossing is discussed for a system with a hamiltonian $\mathcal{H} = A + HB$, H being an external parameter. A crossing is a degeneracy of two or more energy eigenvalues for a discrete value of H. The number of crossings is related with the degree in H of the basis

vectors of the space of operators commuting with $\mathcal{N}$: every crossing reduces the degree of one of these basis vectors, if one starts with a basis consisting of the first n powers of $\mathcal{N}$, n being the dimension of the Hilbert space. It is possible to indicate the maximum number of crossings for a given n. This number being realized, the space of commuting operators is invariant. (auth)

36815 INTERACTION BETWEEN RADIATION AND A TWO-LEVEL SYSTEM: KINETIC EQUATION UP TO ORDER λ^6 AND APPLICATIONS. Henin, F.; De Haan, M. (Univ. Libre, Brussels). Physica, 40: 399-421(Dec. 30, 1968).

This paper is one of a series devoted to the discussion, by means of kinetic equations, of the problem of interaction between radiation and matter. The model used for matter is the Wigner–Weisskopf two-level model. The kinetic equation for quasiparticles (i.e. atom in perturbed levels) is given, without proof, up to order λ^6 (The derivation may be found in another paper). As λ^2 and λ^4 contributions have already been discussed in another work, we concentrate ourselves on the discussion of the λ^6 (3-photon) scattering operator. The kinetic equation is then applied to a discussion of spontaneous emission and resonance light scattering. The connection with the usual Lorentz formula is then discussed. (auth)

36816 A NOTE ON THE SYMMETRIZATION POSTULATE AND CLUSTER PROPERTY. Arons, M. E. (City Coll., New York). Nuovo Cim., Lett., 1: 911-14(June 11, 1969).

Steinman's argument that only totally symmetric or totally antisymmetric wave functions are consistent with the principle of indistinguishability and the cluster property is examined, and a possible modification is briefly discussed. (L.B.S.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 36858, 36859, and 37041.

36817 (TID-25097) LAWRENCE RADIATION LABORATORY, BERKELEY/1966. (California Univ., Berkeley. Lawrence Radiation Lab.). 73p. Dep. CFSTI.

A brief review is given of research programs in physics with emphasis on high-energy physics, accelerators, and associated equipment. Programs in the fields of nuclear chemistry, inorganic materials, biology and medicine, and chemical biodynamics are also reviewed. Education activities and administrative and financial data are also included. (W.H.K.)

Electromagnetic

Refer also to abstract 37039.

36818 HEAVY LIQUID CHAMBER ANALYSIS OF $\eta^0 \to 3\pi$ AND $\eta^0 \to \gamma\gamma$ DECAY-MODES. Baglin, C. (Ecole Polytechnique, Paris); Bezaguet, A.; Degrange, B.; (and others). Phys. Lett., 29B: 445-7(June 23, 1969).

From 199 $\eta^0 \to 3\pi^0 \to 6\gamma$, 526 $\eta^0 \to \pi^+\pi^-\pi^0$ and 401 $\eta^0 \to \gamma\gamma$ events with all γ-rays reconstructed in a heavy liquid bubble chamber, direct and independent measurements of the branching ratios were obtained: $R_1 = \Gamma(\eta^0 \to 3\pi^0)/\Gamma(\eta^0 \to \pi^+\pi^-\pi^0) = 1.50^{+0.13}_{-0.29}$ and $R_2 = \Gamma(\eta^0 \to \gamma\gamma)/\Gamma(\eta^0 \to \pi^+\pi^-\pi^0) = 1.72 \pm 0.25$. We also study the Dalitz-plots for the modes $\eta^0 \to 3\pi^0$ and $\eta^0 \to \pi^+\pi^-\pi^0$, and find no significant variation of the amplitude of the decay $\eta^0 \to 3\pi^0$. (auth)

36819 EXPERIMENTAL INVESTIGATION OF THE POLARIZATION OF SCATTERED RADIATION IN THE COMPTON EFFECT ON RELATIVISTIC ELECTRONS. Kulikov, O. F.; Tel'nov, Yu. Ya.; Filippov, E. I.; Yakimenko, M. N. (Moscow State Univ. Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 9: 310-12(May 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 513-16(May 5, 1969).

The dependence of the degree of linear polarization of scattered photons on their energy was measured at two mutually perpendicular orientations of the electric vector of the laser photons, one of which coincided with the vertical direction (the electron orbit was in a horizontal plane). For these measurements a Compton polarimeter consisting of three scintillation counters was used. The results of the measurements and the corresponding theoretical curves are shown. (J.F.P.)

36820 HIGH-ENERGY MUON–PROTON SCATTERING: MUON–ELECTRON UNIVERSALITY. Camilleri, L. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.); Christenson, J. H.; Kramer, M.; Lederman, L. M.; Nagashima, Y.; Yamanouchi, T. Phys. Rev. Lett., 23: 153-5(July 21, 1969).

Measurements of the μ-p elastic cross section in the range $0.15 < q^2 < 0.85$ (GeV/c)^2 are compared with similar e-p data. An apparent disagreement is found between the muon and electron experiments which can possibly be accounted for by a combination of systematic normalization errors. (auth)

36821 HIGH-ENERGY MUON–PROTON SCATTERING: ONE-PHOTON EXCHANGE TESTS. Camilleri, L. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.); Christenson, J. H.; Kramer, M.; Lederman, L. M.; Nagashima, Y.; Yamanouchi, T. Phys. Rev. Lett., 23: 149-52(July 21, 1969).

Muon-proton elastic scattering was studied in the range $0.15 < q^2 < 0.85$ (GeV/c)^2 with μ^+ and μ^- beams of 6 and 11 GeV/c and a μ^- beam of 17 GeV/c. Cross sections were determined with uncertainties as small as 2%. Rosenbluth straight-line plots and comparisons of the μ^+ and μ^- cross sections show no deviation from the one-photon exchange approximation. (auth)

Weak

36822 (PITHA-29) DEPENDENCE OF NEUTRINO CROSS SECTIONS ON THE ATOMIC WEIGHT OF THE TARGET. Holder, M. (Technische Hochschule, Aachen (West Germany). Physikalisches Institut (III)). [1969]. 8p. Dep.

A comparison of the total neutrino rates in lead and aluminum respectively observed during a spark chamber neutrino experiment is reported. The results show no measurable deviation from the simple A law. (J.F.P.)

36823 (SRO-143) BACKGROUND STUDIES FOR ANTI-NEUTRINO EXPERIMENTS. Progress Report. Avignone III, F. T.; Darden III, C. W. (South Carolina Univ., Columbia. Dept. of Physics). Jan. 1968. Contract AT(38-1)-474. 28p. Dep. CFSTI.

The neutron background was measured at several locations near one of the Savannah River Production reactors. At the location where the neutron background was the lowest of those measured, the gamma ray background was measured inside several shielded enclosures. These studies showed that lead alone is not nearly so effective in reducing the γ-ray background as a combination of lead and boron impregnated polyethylene. Apparatus for measuring coincidences between gamma rays near 0.511 MeV has been assembled and tested away from the reactor, under several conditions. It was found that background coincidences were almost entirely due to gamma rays scattering between the crystals. A live shield, sensitive mainly to the hard muon component of the cosmic ray background, was not found to be effective in the reduction of background coincidences in this energy region. (auth)

36824 MEASUREMENT OF THE RATIO OF AXIAL-VECTOR TO VECTOR CURRENT IN THE DECAY $\Sigma^- \to ne^-\bar{\nu}$. Colleraine, A. P.; Day, T. B.; Glasser, R. G.; Knop, R.; Sechi-Zorn, B.; Snow, G. A. (Univ. of Maryland, College Park). Phys. Rev. Lett., 23: 198-201(July 28, 1969).

From approximately 550 Σ^- electronic decays produced by stopping K^- in liquid hydrogen a sample of 49 events was selected in which the neutron from the Σ^- leptonic decay is detected by a subsequent n-p scatter. A maximum-likelihood analysis, including the effect of about 20% background, indicates that the magnitude of the ratio of the coupling constants is $|G_a/G_v| = 0.23 \pm 0.16$, in excellent agreement with the prediction of the Cabibbo theory. (auth)

36825 A NEW FIT OF THE PARAMETERS FOR CABIBBO'S THEORY. Eisele, F.; Engelmann, R.; Filthuth, H.; Foehlisch, W.; Hepp, V.; Leitner, E.; Presser, W.; Schneider, H.; Zech, G. (Univ., Heidelberg). Z. Phys., 225: 383-92(1969).

New measurements of baryon leptonic decay rates and form factor ratios make a new comparison with the Cabibbo theory desirable. The data are consistent with the one-angle Cabibbo theory, the results for the three free parameters are: $\Theta = 0.239 \pm 0.006$, $g_1^F = 0.488 \pm 0.020$, $g_1^D = 0.743 \pm 0.020$. (auth)

36826 MUON POLARIZATION IN $K^0_{\mu 3}$ DECAY. Longo, Michael J. (Univ. of Michigan, Ann Arbor); Young, Kenneth K.; Helland, Jerome A. Contracts NONR 1224(23); AT(11-1)-34. Phys. Rev., 181: 1808-23 (May 25, 1969).

An experiment to measure the polarization of muons from $K^0_{\mu 3}$ decay was carried out at the Bevatron with counter techniques. All three components of the polarization were measured. The time-reversal-violating component transverse to the decay plane was found to be $\langle P_T^{em} \rangle = -0.005 \pm 0.019$, which is consistent with T invariance. The result for the form-factor ratio $\xi \equiv f_-/f_+$ was $\mathrm{Re}\xi = -1.81^{+0.50}_{-0.28}$, $\mathrm{Im}\xi = -0.02 \pm 0.08$, $\mathrm{Arg}\ (\xi) - \pi = (0.6 \pm 2.6)°$, if ξ is assumed to be independent of q^2. If ξ is not too strongly dependent on q^2, this result still holds true for ξ at $q^2 \cong 2.65\ m_\pi^2$, the average q^2 selected by our apparatus. (auth)

Strong (Baryon-Induced)

36827 (COO-7-506) ANGULAR DISTRIBUTION OF 24-MeV NEUTRONS SCATTERED BY PROTONS. Rothenberg, L. N. (Wisconsin Univ., Madison). June 16, 1969. Contract AT(11-1)-Gen-7. 3p. (CONF-690804-1). Dep. CFSTI.

From International Conference on Properties of Nuclear States, Montreal, Canada.

A counter telescope was used to detect recoil proton spectra from n + p elastic scattering at an incident neutron energy of 24.0 MeV. The differential cross sections were obtained from the normalization of the cm relative angular distribution to a total cross section of 397.2 mb measured previously. (J.F.P.)

36828 (NYO-2262-TB-145) PROGRESS REPORT OF A RESEARCH PROGRAM IN EXPERIMENTAL HIGH ENERGY PHYSICS. Shapiro, Anatole M. (Brown Univ., Providence, R. I. Dept. of Physics). June 1, 1969. Contract AT(30-1)-2262. 13p. Dep. CFSTI.

A summary of the progress made in experimental high-energy physics during the year September 1, 1968, to August 31, 1969, is presented. Data analysis in progress and experimental runs in progress and in preparation are discussed, and a list of papers published during the year and papers in press is given. (J.F.P.)

36829 28 GeV PROTON AND 16.2 GeV NEGATIVE PION INTERACTIONS WITH HYDROGEN. Magnuson, C. E.; Jain, P. L. (State Univ. of New York, Buffalo). Nucl. Phys., B11: 464-78(1969).

An experimental study was made of the elastic and the inelastic interactions produced by 28 GeV proton and 16.2 GeV negative pion beams with free hydrogen nuclei in nuclear emulsions. In the proton and the pion beams, 862 and 503 events were found respectively by following "along the track" scanning technique. Out of these, 10 proton and 4 pion events were classified as p-p and π-p (free hydrogen nuclei) elastic interactions. The elastic cross section values are 9.31 ± 2.94 mb and 5.4 ± 2.7 mb respectively. While the total inelastic cross sections for both types of interactions (i.e., pp and πp) vary slowly with energy, the partial inelastic cross sections were found to be strongly energy dependent. Finally, the correlation indicated (by our experimental data) between the elastic cross section, total cross section and the transverse momentum of the secondary particles produced in the interactions is discussed and is compared with the theory. (auth)

36830 FOUR-PRONG ANNIHILATION OF 1.2 GeV/c ANTIPROTONS IN HYDROGEN. II. $\pi^+\pi^+\pi^-\pi^-\pi^0$ FINAL STATE. Donald, R. A. (Liverpool Univ.); Edwards, D. N.; Moore, R. S.; (and others). Nucl. Phys., B11: 551-72(1969).

Approximately 17,000 four-prong annihilations of 1.2 GeV/c antiprotons in hydrogen were analyzed. The present report considers those events with one neutral pion (5π). The 5π events show production of ρ^0, $\rho^\pm$, f^0, ω^0, η^0 mesons, and the possibility of a $\rho\rho$ enhancement at 1400 MeV/c and/or a $\rho\pi$ enhancement at 1080 MeV/c is considered. The influence of the Bose-Einstein correlation function of Goldhaber et al. is investigated. Centre-of-mass angular distributions of the pions and centre-of-mass opening angles between pairs of pions are presented. The production upper limits at the 95% confidence level, for several resonant states are given. (auth)

36831 SEARCH FOR STRUCTURES IN THE $\bar{p}p \to \bar{n}n$ CROSS SECTION BETWEEN 1 AND 3 GeV/c. Bricman, C. (CERN, Geneva); Ferro-Luzzi, M.; Perreau, J. M.; Walker, J. K.; Bizard, G.; Declais, Y.; Duchon, J.; Seguinot, J.; Valladas, G. Phys. Lett., 29B: 451-4(June 23, 1969).

The $\bar{p}p \to \bar{n}n$ partial cross section was measured in the region of antiproton laboratory momenta between 1 and 3 GeV/c. The implications of these results on the existence of boson resonances decaying into $N\bar{N}$ are discussed. (auth)

36832 DEPENDENCE OF THE ENERGY OF AN ELECTRON-PHOTON CASCADE, PRODUCED BY COLLISION OF A NUCLEAR-ACTIVE COSMIC-RAY PARTICLE WITH A LEAD NUCLEUS, ON THE ENERGY OF THE INTERACTING PARTICLE. Nam, R. A.; Nikol'skii, S. I.; Pavlichenko, V. P.; Sokolovskii, V. I.; Yakovlev, V. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 9: 198-200(Mar. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 338-40(Mar. 20, 1969).

Preliminary results are presented from data concerning the fraction of the interacting-particle energy transferred to the electron–photon cascade in one inelastic collision. The energy of particles producing the avalanches was $5(10)^{11}$ to $2(10)^{13}$ eV. A reliable result was obtained indicating that the average values of the fraction of the nuclear-active-particle energy transferred in the first collision to the electron–photon cascade is constant in interactions between nucleons (or pions) and lead nuclei in the energy interval studied. (J.F.P.)

Strong (Meson-Induced)

Refer also to abstracts 35468, 35514, and 36829.

36833 (ITEF–638) THE ELASTIC BACKWARDS SCATTERING OF π^- MESONS ON NEUTRONS IN THE INTERVAL OF IMPULSES 1.5 TO 3.8 GeV/c. Antopol'skii, V. D.; Bayatyan, G. L.; Brakhman, E. V.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1968. 24p. (In Russian). Dep.

The elastic π^-_n backwards scattering in the momentum interval 1.5 to 3.8 GeV/c was investigated. The backwards scattering of pions was detected in spark chambers, surrounding the target with liquid deuterium; the forward scattering of neutrons was recorded in spark chambers of a neutron detector. Measuring the angle of backwards scattering of a pion and the point of interaction of the recoil neutron, it was possible to determine the kinematics of the elastic event. Data in regard to the dependence of the differential cross section on the energy in the momentum interval 1.5 to 3.8 GeV/c and the angular distribution for $-0.93 > \cos\theta^* > -1$ are presented. (auth)

36834 (NYO–2171-271) DETERMINATION OF δ^0_3 AND δ^1_3 FROM CHEW–LOW EXTRAPOLATION. Hagopian, V.; Bogart, E.; Marateck, S.; Selove, W. (Pennsylvania Univ., Philadelphia). May 1969. Contract AT(30-1)-2171. 30p. (CONF-690521–1). Dep. CFSTI.

From Conference on the π–π and K–π Interactions, Argonne, Ill.

Details of the Chew–Low extrapolation for a determination of δ^0_3 and δ^1_3 from the interactions $\pi^- + p \to \pi^- + \pi^+ (\pi^0) + n(p)$ are presented. The $\pi\pi$ mass plots, the ρ density matrix elements, a brief description of the Chew–Low extrapolation formalism, the four-momentum distribution if OPE were exact in the physical region, the various extrapolations for resonances, and the $\pi^0\pi^0$ mass spectra are covered. (J.F.P.)

36835 (UCRL-19208) $\pi^\pm$–α SCATTERING AND THE PION FORM FACTOR. Fainberg, Anthony (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 2, 1969. Contract W-7405-eng-48. 69p. Dep. CFSTI.

Thesis.

A measurement of the $\pi^\pm$–^{4}He scattering was made at 53, 60, 68, and 75 MeV incident pion lab energy. The resulting differential cross sections are presented. An attempt was made to extract the pion electromagnetic form factor using the difference in the π^+ and π^- cross sections which is sensitive to the Coulomb contribution to the total scattering amplitude. An optical model potential was postulated for the nuclear part of the interaction. Various methods were used to extract the form factor, with a view to minimizing model dependence. The most detailed model available, using a method of analysis designed to reduce this dependence gives R = 2.96 ± 0.43F. Possible uncertainties in the model and its application are also discussed. (auth)

36836 (UH–511-48-69) STUDY OF THE REACTION $\pi^-p \to \pi^-\pi^-\pi^+p$ AT 3.9 GeV/c. Wohlmut, P. G.; Abe, K.; Johnson, A. D.; Stenger, V. J. (Hawaii Univ., Honolulu). Apr. 1969. Contract AT(04-3)-511. 16p. (CONF-690612-1). Dep. CFSTI.

From International Conference on Elementary Particles, Lund, Switzerland.

An excellent fit to 7975 events of the reaction $\pi^-p \to \pi^-\pi^-\pi^+p$ at 3.9 GeV/c was found using a model of pion-exchange, diffraction dissociation, and rho-exchange processes adding incoherently. Monte Carlo events generated according to the model exhibit mass, momentum transfer, and angular distributions which are virtually identical with the real data in all major respects. (auth)

36837 PRODUCTION OF STRANGE PARTICLES IN 10 GeV/c K^-p INTERACTIONS AND COMPARISON WITH THE PREDICTIONS OF THE MULTIPERIPHERAL MODEL. Bartsch, J. (Technische Hochschule, Aachen); Deutschmann, M.; Hermanns, M.; (and others). Nucl. Phys., B11: 373-82(1969).

The final states $YK\bar{K}$ + pions and Ξ^-K + pions were studied in K^-p interactions at 10 GeV/c. The distributions of the c.m. longitudinal and transverse momenta of particles produced in channels of multiplicity 3 to 7 are discussed. The results are compared with the predictions of the multiperipheral Regge-pole exchange model. (auth)

36838 COHERENT K^-d INTERACTIONS AT 3 GeV/c. Hoogland, W. (Zeeman Laboratorium, Amsterdam); Kluyver, J. C.; Tenner, A. G. (and others). Nucl. Phys., B11: 309-29(1969).

Interactions in which the deuteron remains intact were observed in a 3-GeV/c K^-d bubble chamber experiment. The K^-d elastic scattering data are consistent with results on K^-N elastic scattering at the same incident momentum, in the context of the impulse approximation. A similar conclusion is made regarding the reaction $K^-d \to K^{*-}d$, which accounts for nearly 100% of the reaction $K^-d \to \bar{K}^0\pi^-d$. The decay properties of the K^* for this process indicate that the production is consistent with ω-exchange. The reactions $K^-d \to K^+\pi^-\pi^-d$ and $K^-d \to \bar{K}^0\pi^-\pi^0d$ are strongly dominated by K^* production (both $\bar{K}^{*0}$ and K^{*-} in the second reaction). Several mechanisms were considered which may lead to this final state and be compared with the experimental data. Evidence is shown for diffractive scattering at the deuteron vertex, but no confirmation was seen for the assumption of strong resonance production in the region $m(K\pi\pi) \approx 1.3$ GeV/c^2 (the Q-region). (auth)

36839 STRANGE PARTICLE PRODUCTION IN 8 GeV/c POSITIVE PION INTERACTIONS IN HYDROGEN. Aderholz, M. (Technische Hochschule, Aachen); Bartsch, J.; Schulte, R. (and others). Nucl. Phys., B11: 259-76(1969).

Results are presented on strange particle production in 8 GeV/c π^+p interactions with three and four particles in the final state. Total cross sections for different channels and for production of different resonances are estimated. Differential cross sections for quasi two-body reactions are given. Evidence is presented for the production of a (ΛK) enhancement with a mass of 1755 ± 21 MeV and a full width of 220 ± 60 MeV. Branching ratios for rare decay modes of A_1, A_2, f^0 and f' into strange particles are given. In the ($K\bar{K}\pi$) mass distribution possible enhancements are observed at 1490 and 1690 MeV. (auth)

36840 LONGITUDINAL PHASE SPACE ANALYSIS OF THREE-BODY FINAL STATES IN MESON–NUCLEON COLLISIONS. Bialas, A.; Eskreys, A.; Kittel, W.; Pokorski, S.; Tuominiemi, J. K.; van Hove, L. (CERN, Geneva). Nucl. Phys., B11: 479-94(1969).

The longitudinal phase-space analysis is applied to various three-body final states of meson-nucleon collisions at 5 to 16 GeV/c primary momentum. The distributions of the angle ω along the hexagonal phase space plot and the dependence of average transverse momenta on ω are investigated in some detail. From the very rich structure of the ω distributions it is possible to conclude that, whenever allowed, the diffraction mechanism (single Pomeranchuk exchange) dominates the three-body reactions at high energy. The study of the transverse momentum distributions reveals the existence of strong correlations between longitudinal and transverse momenta which cannot be explained by phase-space effects. Some consequences of our analysis for the Regge-exchange models are briefly mentioned. (auth)

36841 DIFFERENTIAL AND TOTAL CROSS SECTIONS FOR $\pi^- + p \rightarrow \eta + n$ FROM 718 TO 1050 MeV/c. Deinet, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.); Mueller, H.; Schmitt, D.; Staudenmaier, H.-M.; Bunyatov, S.; Zavattini, E. Nucl. Phys., B11: 495-504(1969).

The reaction $\pi^- + p \rightarrow \eta + n$ ($\eta \rightarrow$ neutrals) was studied by a neutron missing-mass spectrometer. Using 160 cm long neutron counters with electronic determination of the interaction point, a wide-angle range was covered. The angular distributions become clearly anisotropic at 763 MeV/c. (auth)

36842 PION–DEUTERON ELASTIC DIFFERENTIAL CROSS-SECTION AT 994 MeV/c. Bradamante, P.; Conetti, S.; Fidecaro, G.; (and others) (CERN, Geneva. CERN, Trieste, Italy). Nuovo Cim., Lett., 1: 894-6(June 11, 1969).

Differential cross sections for $\pi^-d \rightarrow \pi^-d$ interactions at 994 MeV/c were measured as a test of the Glauber multiple scattering theory. The data are tabulated and plotted. (L.B.S.)

36843 MEASUREMENT OF POLARIZATION IN K^+p ELASTIC SCATTERING AT 1.37, 1.45, 1.71, AND 1.89 GeV/c AND PHASE-SHIFT ANALYSIS. Asbury, J. G. (Argonne National Lab., Ill.); Dowell, J. D.; Kato, S.; Lundquist, D.; Novey, T. B.; Yokosawa, A.; Barnett, B.; Koehler, P. F. M.; Steinberg, P. Phys. Rev. Lett., 23: 194-8(July 28 1969).

Measurements are reported of polarization in K^+p elastic scattering at 1.37, 1.45, 1.71, and 1.89 GeV/c. A phase-shift analysis including these new data was performed. Resonancelike behavior is observed in the $P_{\frac{3}{2}}$ partial-wave amplitude. (auth)

36844 POLARIZATION IN K^+-p ELASTIC SCATTERING AT 3.75 AND 4.40 GeV/c. Booth, N. E. (Univ. of Chicago); Conforto, G.; Esterling, R. J.; Parry, J.; Scheid, J.; Sherden, D.; Yokosawa, A. Phys. Rev. Lett., 23: 192-4(July 28, 1969).

The polarization parameter in K^+-p elastic scattering was measured at 3.75 and 4.40 GeV/c in the range of squared momentum transfer $0.2 \lesssim -t \lesssim 1.0$ (GeV/c)^2. The data are compared with the predictions of recent Regge-pole models. (auth)

36845 BACKWARD ELASTIC π^+p SCATTERING FROM 2.18 TO 5.0 BeV/c. Chandler, J. P.; Crittenden, R. R.; Galloway, K. F.; Heinz, R. M.; Neal, H. A.; Potocki, K. A.; Prickett, W. F.; Sidwell, R. A. (Indiana Univ., Bloomington). Phys. Rev. Lett., 23: 186-9(July 28, 1969).

Differential cross sections for π^+p elastic scattering in the angular region $-0.6 \gtrsim \cos\theta_{c.m.} \gtrsim -0.98$ are presented for 13 incident pion momenta from 2.18 to 5.0 BeV/c. The striking features of the data are a backward peak at all momenta and a dip in the cross section at $u \approx -0.17$ for momenta between 2.75 and 5.0 BeV/c. (auth)

36846 DIFFERENTIAL CROSS SECTION AND POLARIZATION IN THE REACTION $\pi^+ + p \rightarrow K^+ + \Sigma^+$ FROM 3 TO 7 GeV/c. Pruss, S. M. (Univ. of Michigan, Ann Arbor); Akerlof, C. W.; Meyer, D. I.; Ying, S. P.; Lales, J.; Lundy, R. A.; Rust, D. R.; Ward, C. E. W.; Yovanovitch, D. D. Phys. Rev. Lett., 23: 189-92 (July 28, 1969).

The differential cross section and polarization for the reaction $\pi^+ + p \rightarrow K^+ + \Sigma^+$ were measured for K laboratory angles between 3° and 17°. The reaction is dominated by a large forward peak which shrinks rapidly and decreases slowly in size with increasing energy. A break in this exponential occurs at $-t = 0.4$ (GeV/c)^2 beyond which the cross section falls much more slowly. The polarization is small for values of $-t$ less than 0.3 beyond which it becomes large and positive and remains positive to the largest angles measured. It is independent of energy within experimental errors. (auth)

36847 INVESTIGATION OF THE MECHANISM OF ELECTRON–POSITRON PAIR PRODUCTION IN π^-p INTERACTIONS AT 10 GeV/c. Boos, E. G.; San'ko, L. A.; Takibaev, Zh. S.; Temiraliev, T. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. No. 4, 1-5(July-Aug. 1968). (In Russian).

Electron-positron pairs in the center of stars formed by π^- mesons with 10 GeV/c momentum in the CERN 81 cm hydrogen bubble chamber are analyzed. The invariant mass distribution of the e^-e^+ pairs and the determination of their production probability do not contradict the premise that these pairs are the consequence of the decay of neutral mesons according to the Dalitz scheme $\pi^0 \rightarrow e^-e^+$. The momentum distribution of γ quanta, which were recorded in the effective volume of the chamber, is transformed in the momentum distribution of π^0 mesons, the average energy of π^0 mesons was 1.28 ± 0.16 GeV/c within the limits of errors will conform with the corresponding value for π^+ mesons 1.1 ± 0.07 GeV/c. The average number of π^0 mesons in one four-pronged interaction is about 2.2 ± 0.2. The part of the energy transmitted to the neutral pions in the laboratory system of coordinates was 0.26 ± 0.04. (tr-auth)

36848 NEUTRAL $\pi\rho$ ENHANCEMENTS PRODUCED IN 8-GeV/c π^+d INTERACTIONS. Kenyon, I. R. (Brookhaven National Lab., Upton, N. Y.); Kinson, J. B.; Scarr, J. M.; Skillicorn, I. O.; Cohn, H. O.; McCulloch, R. D.; Bugg, W. M.; Condo, G. T.; Nussbaum, M. M. Phys. Rev. Lett., 23: 146-9(July 21, 1969).

Enhancements in the A region and at 1.670 GeV are observed decaying into $\pi\rho$. The A_1 enhancement is not well described by a simple charge-exchange Deck effect. The isoscalar character of the 1.670-GeV enhancement is confirmed. (auth)

36849 EVIDENCE FOR AN $\omega\pi\pi$ RESONANCE IN THE I = 1 STATE AT A MASS OF 1695 MeV. Barnes, V. E.; Chung, S. U.; Eisner, R. L.; Flaminio, E.; Guidoni, P.; Kinson, J. B.; Samios, N. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 23: 142-5(July 21, 1969).

Evidence is presented for the existence of a boson resonance with mass M = 1695 ± 20 MeV and width Γ = 90 ± 20 MeV. It decays principally into $\omega\rho$ and $\omega\pi\pi$ and has G = −1 and I = 1. This state can be interpreted either as a new resonance, further complicating the R region, or as an alternative decay of the π(1640); the latter would require an $\omega\pi\pi/I\pi$ branching ratio greater than 4. (auth)

36850 STUDY OF THE REACTION $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ FROM 1.2 to 1.7 GeV/c. Huwe, Darrell O. (Univ. of California, Berkeley). Phys. Rev., 181: 1824-53(May 25, 1969).

A sample of events of the reaction $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ was selected from an exposure of the Laboratory's 72-in. hydrogen bubble chamber to a separated K^- beam of the Bevatron. The laboratory momentum of the K^- in this sample was set at six values, ranging from 1.22 to 1.69 BeV/c. A sample at lower energy was also used in part of the analysis. Dalitz plots and effective-mass distributions show that the Λ-π resonance, Y_1^* (1385), is the dominant final state; the π-π resonance, ρ (750), also important, has a maximum cross section at 1.5 BeV/c; and Y_1^* (1660) is produced weakly. The angular correlations of the decay products of the Y_1^* (1385) were also studied and it was determined that the spin-parity of this resonance is $P_{\frac{3}{2}}$, with a slight chance that it is $D_{\frac{3}{2}}$. With this spin-parity assignment, all of the observed properties of the Y_1^* (1385) are consistent with assignment to a decuplet in the eightfold-way theory. There is evidence of the initiation of peripheral production of Y_1^* (1385) above 1.5 BeV/c, but this process is not yet dominant at 1.7 BeV/c. (auth)

36851 EXPERIMENTAL TEST OF THE PION–NUCLEON FORWARD DISPERSION RELATIONS AT HIGH ENERGIES. Foley, K. J.; Jones, R. S.; Lindenbaum, S. J.; Love, W. A.; Ozaki, S.; Platner, E. D.; Quarles, C. A.; Willen, E. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 181: 1775-93(May 25, 1969).

The small-angle differential scattering cross sections of protons for pions were measured to high precision at the Brookhaven AGS. The range of incident momenta was 8 to 20 GeV/c for π^+, and 8 to 26 GeV/c for π^-. The real part of the pion-nucleon forward scat-

tering amplitude was determined by observing its interference with the known Coulomb amplitude. Combining these results with precision measurements of pion-proton total cross sections over this energy range provided a critical test of the predictions of the forward dispersion relations. The results demonstrate the validity of the dispersion relations up to at least 20 GeV/c laboratory momentum. The predictions of charge independence are also verified by comparing these experimental measurements with forward charge-exchange scattering cross sections. Furthermore, if microscopic causality is violated, this occurs at "distances" less than 10^{-15} cm. (auth)

36852 HIGH-ENERGY ELASTIC SCATTERING OF $\pi^{\pm}$, K^-, AND $\bar{p}$ ON HYDROGEN AT c.m. ANGLES FROM 22° TO 180°. Owen, D. P.; Peterson, F. C.; Orear, J.; Read, A. L.; Ryan, D. G.; White, D. H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 181: 1794-1807(May 25, 1969).

Elastic $\pi^{\pm}$-p, K^--p, and $\bar{p}$-p scattering cross sections were measured using three different experimental arrangements covering the c.m. angular regions ~20°–120°, ~135°–169°, and ~165°–180° at incident momenta from 6 to 17 GeV/c. In the region 130°–180°, only $\pi^{\pm}$-p scattering was measured. In the angular region near 180°, the energy dependences and shapes of the π-p backward peaks were determined up to crossed-momentum transfers of u ~−2 $(GeV/c)^2$. At all energies, the π^+-p backward peak had a sharp dip at u = −0.13 $(GeV/c)^2$, with no similar effect in the π^--p case. Nearly complete angular distributions of π^--p elastic scattering from 20° to 180° were obtained at 6 and 10 GeV/c. These results at 6 and 10 GeV/c as well as at 8 GeV/c reveal a sharp dip in π^--p scattering at t = −3 $(GeV/c)^2$. Several structures in the form of dips or shoulders were seen in the $\bar{p}$-p angular distributions also, with less pronounced structure observed in K^--p scattering. At fixed momentum transfer, all cross sections when expressed as $d\sigma/dt$ appear to be decreasing with increasing energy. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 37003, 37009, and 37041.

36853 (JINR-D2-4534) CLOSED UNIVERSE AND LAWS OF CONSERVATION OF ELECTRIC, BARYON, AND LEPTON CHARGES. Markov, M. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 29p. (In Russian). Dep.

As is known the electrically charged matter excludes a closed metric of the world. The closed world should be electrically neutral. In modern theory baryon and lepton charges are treated as appropriate analogs of the electric charge. The question is discussed to what extent this analogy is conserved in the closed world. Some effects in the physics of assemblies of near-closed objects are considered. (auth)

36854 (JINR-P1-4419) IDENTIFICATION OF THE RESONANCE PRODUCTION REACTIONS. Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 17p. (In Russian). Dep.

A new functional to identify the reactions producing resonance is proposed. The usual functional (5) is criticized. It implies that the experimental errors $\Delta_{P\alpha}$ are small as compared to the width of the region on the energetical surface in which the density $M^2(P^0)$ of the true events varies sharply. The functional implies also that the errors are normally distributed; this is not valid for spherical momenta components (like θ, ϕ or tg α). The functional which takes into account the variation of density is (9). It is shown that the point R which minimizes the form (9) is nearer to true event P^0 than the point P which minimizes the form (5). But this estimate R of P^0 is biased ($\langle R \rangle \neq P^0$). The identification of a reaction when the experimental error $\Delta_{P\alpha}$ is comparable with the resonance width Γ_A is considered. In this case the minimization of the form, where $B_A(m_{23})$ is the Breit–Wigner function, will give the better estimates of events. The criterion of identification is $\chi^2_{min} \leq s$ (s-number of constraints), but this value s will be reached easier because of the extra term $-\ln B_A$. The form discussed will facilitate the identification of dubious events, which equally satisfy both the hypotheses. Also the other forms of $M^2(P)$ are discussed: the Regge peaks or the experimental angular distributions. (auth)

36855 (JINR-P2-4461) NONRELATIVISTIC TRANSFORMATIONS OF THE COORDINATES AND THE INVARIANCE OF THE NONRELATIVISTIC HAMILTON-JACOBI EQUATION. Strel'tsov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 10p. (In Russian). Dep.

Nonrelativistic transformations of the coordinates: $x' = (x - vt)[1 + (1/2)(v^2/c^2)]$, $t' = t[1 + (1/2)(v^2/c^2)] - [(v/c^2)x]$, were considered. It is shown that the conventional nonrelativistic Hamilton–Jacobi equation corresponds to just the given approximation, whereas in the Galilean approximation it is of the type: $\partial S_1/\partial t = 0$. (auth)

36856 (JINR-P2-4462) NONRELATIVISTIC TRANSFORMATIONS OF COORDINATES AND TRANSITION FROM THE KLEIN-GORDON EQUATION TO THE NONRELATIVISTIC WAVE EQUATION. Strel'tsov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1969. 12p. (In Russian). Dep.

It is shown that the Schroedinger equation is noninvariant relative to the nonrelativistic transformations of the coordinates. As nonrelativistic limit of the Klein–Gordon equation an expression of the type: $[\psi(\partial^2\psi/\partial t^2)]^{1/2} - (imc^2/\hbar)\psi = -(i\hbar/2m)\cdot(\partial^2\psi/\partial x^2)$ is proposed which satisfies the mentioned invariance requirement. (auth)

36857 (NYO-2262-TA-206) PROGRESS REPORT FOR A RESEARCH PROGRAM IN THEORETICAL HIGH-ENERGY PHYSICS. Feldman, David (Brown Univ., Providence, R. I. Dept. of Physics). June 1, 1969. Contract AT(30-1)-2262. 8p. Dep. CFSTI.

A summary of the progress made in theoretical high-energy physics during the year September 1, 1968, to August 31, 1969, is presented. The present status of the theoretical group is discussed, and a list of papers published during the year and papers in press is given. (J.F.P.)

36858 HIGH ENERGY PHYSICS INDEX. Volume 7, Number 11, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 74p.

36859 HIGH ENERGY PHYSICS INDEX. Volume 7, Number 10, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 67p.

36860 ASYMPTOTIC CONDITIONS OF STATIC SPHERICALLY SYMMETRIC SPACE-TIMES WITH SHORT-RANGE POTENTIALS. Yokoyama, Kan-ichi (Hiroshima Univ.). Tensor, 20: 5-12(Jan. 1969).

The possibility of formulating a theory of the internal space of elementary particles with a Riemannian geometry is examined under certain assumptions. (J.F.P.)

36861 DEFINITION AND INTERPRETATION OF MULTI-PATH OPERATORS IN RELATIVISTIC SCATTERING THEORY. I. Genz, Henning (Univ., Munich). Acta Phys. Austr., 27: 299-322(1968). (In German).

It was shown that the description given by Bopp of free fermions in the new antiparticle representation (NAV) is equivalent with the usual description under the assumption of a special physical interpretation. The NAV was generalized for free bosons. (tr-auth)

36862 SOLUTION OF NONRELATIVISTIC PARTIAL-WAVE DISPERSION RELATIONS. Johnson, Porter W. (Case Western Reserve Univ., Cleveland). Contract 342-2865. Phys. Rev., 181: 2006-10(May 25, 1969).

The partial-wave dispersion-relation (PWDR) problem is studied in the nonrelativistic elastic case. In particular, a set of conditions on the left-hand-cut discontinuity is obtained which is sufficient to guarantee that the PWDR problem has a solution. The nature of the solutions so obtained and the possible extensions are discussed. (auth)

36863 SCHWINGER TERMS IN STRESS-TENSOR COMMUTATORS. Mahanthappa, K. T. (Univ. of Colorado, Boulder). Contract AF-AFOSR-30-67. Phys. Rev., 181: 2087-90(May 25, 1969).

It is demonstrated that, in general, the Schwinger terms in the vacuum expectation values of equal-time stress-tensor commutators with odd number of time indices must consist of fifth derivatives in addition to the third derivatives of the three-dimensional-space δ function. Relevance of these considerations to the stress-tensor of the Sugawara theory is indicated. (auth)

36864 SUM RULES FOR TOTAL CROSS SECTIONS FROM SUGAWARA'S THEORY OF CURRENTS. Grotch, H. (Pennsylvania State Univ., University Park). Phys. Rev., 181: 2045-7 (May 25, 1969).

From Sugawara's theory of currents a number of sum rules are derived, some of which have previously appeared in the literature. These are now expressed in terms of total absorption cross sections for vector currents. It is shown that these sum rules imply that for fixed q and timelike q^2, where q_μ is the four-

momentum associated with the current, the cross sections go to zero as $q^2 \to \infty$. In particular, the cross sections for absorption of transverse and longitudinal photons vanish for large timelike q^2. (auth)

36865 PHYSICALLY NONREALIZABLE VECTORS AND SUPERSELECTION RULES. Kharatyan, S. G. (Moscow State Univ.). Yadern. Fiz., 9: 1305-9(June 1969). (In Russian).

An exact definition of the superselection rules is proposed. The connection between the general assumptions of quantum theory and commutativity of the superselection rules and discreteness of the superselection operator spectrum is discussed. The spectrum of the superselection operators is proved from one of the postulates to be descrete. The problem of physically nonrealizable vectors in the theories compatible with the postulates discussed is formulated and solved. (auth)

36866 ELASTIC AND INELASTIC PROCESSES AT HIGH ENERGIES WITH EMISSION OF THE PRODUCED PARTICLES IN THE REGION OF OREAR ANGLES. Anisovich, V. V.; Khrustalev, O. A. Yadern. Fiz., 9: 1258-73(June 1969). (In Russian).

The following assumptions are made for particle interactions at high energies: (1) the reactions proceed mainly in a peripheral or multiperipheral way, (2) at the momentum transfers $-t_i \lesssim 0.5$ GeV^2 the amplitudes behave as exp $(a_i t_i)$, with some constant a_i. With account of the exponential t_i dependences only, the s-channel unitarity provides the following properties of the amplitudes in the Orear region ($-t_i > 0.5 - 1$ GeV^2, $s \gg -t_i$): (1) the elastic amplitude for A + B → A + B decrease with the momentum transfer as exp $(-b_{AB}\sqrt{-t})$, with a constant b_{AB}; (2) the charge exchange and backward scattering amplitudes decrease after the same law, with the same b_{AB}; (3) the same law is also valid for the reaction A + B → C + D, with the t-channel exchange by nonzero quantum numbers, with $b = \min (b_{AB}, b_{CD})$, (4) the multiperipheral processes with the momentum transfer in the Orear region A + B → a + b + c . . . , are rather probable if the all produced particles are emitted along one direction in the c.m.s.; the amplitudes behave as exp $[-b_{AB}(\sqrt{s}/2)\theta]$, where θ is the angle of emission of the produced particles. (auth)

Electromagnetic

Refer also to abstracts 36892 and 37004.

36867 (DESY-69/18) VECTOR MESON DOMINANCE AND DIFFRACTIVE ELECTROPRODUCTION OF VECTOR MESONS. Fraas, H.; Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1969. 33p. Dep.

A vector meson dominance model of diffractive electroproduction of vector mesons at high energies is presented. The assumption that the invariant amplitudes are slowly varying as a function of the vector meson mass, when extrapolating to the spacelike region, is shown to lead to serious difficulties when combined with helicity independence, i.e., equality of transverse and longitudinal on mass shell vector meson forward scattering helicity amplitudes at high energies. The assumption is adopted, therefore, that the helicity amplitudes are slowly varying, apart from the factors which guarantee the vanishing of the longitudinal amplitudes in the limit of zero mass. Assuming, in addition, helicity nonflip and helicity independence for vector meson scattering, expressions for the cross section for electroproduction of vector mesons and for the vector meson spin density matrix elements are derived. Also the conclusions on the total electroproduction cross section are presented. (auth)

36868 (SLAC-Trans-96) PHOTOPRODUCTION OF π^0 MESONS ON NUCLEI AT HIGH ENERGIES. Tsarev, V. A. Translated by T. Watt (Stanford Linear Accelerator Center, Calif.), from Russian preprint LEBEDEV-69-6. 27p. Dep. CFSTI.

It is shown that measurements of the cross section for the photoproduction of π^0 mesons on nuclei can be used (1) to investigate the Regge trajectory of the ω meson; (2) to determine the sign of the amplitude for the $\pi^0 \to 2\gamma$ decay, and (3) to verify the predictions of the vector dominance model. (auth)

36869 LOW-ENERGY THEOREM FOR COMPTON SCATTERING BY A SPIN-½ PARTICLE, WITHOUT C, P, AND T-INVARIANCE. Almond, D. J. (Oxford Univ.). Nucl. Phys., B11: 277-85(1969).

The amplitude for the scattering of a photon by a spin-½ particle is calculated exactly in quantum field theory, to first order in the photon energy, assuming no invariance principles other than gauge invariance and invariance under proper, orthochronous, inhomogeneous Lorentz transformations. It is found that, as in the C, P, and T-invariant theory, the scattering amplitude is determined by the static properties of the spin-½ particle, in this case the mass, charge, magnetic moment, and electric dipole moment. A generalization of the Gerasimov-Drell-Hearn sum-rule is also derived. (auth)

36870 THE γ-ρ^0 COUPLING CONSTANT, COMPTON SCATTERING, AND TOTAL HADRONIC γ-p CROSS SECTIONS. Guiragossian, Zaven G. T.; Levy, Aharon (Stanford Univ., Calif.). Nucl. Phys., B11: 449-54(1969).

A vector dominance model relation, free of interference terms, was tested to discriminate for values of the γ_ρ coupling constant in favor of $\gamma_\rho^2/4\pi = 0.52$. The diffractive part of Compton scattering is examined under a ρ-dominance assumption and compared with ρ^0 photoproduction, and the behavior of $\sigma_{tot}(\gamma p)$ at high energies is shown. (auth)

36871 ON THE PROBLEM OF INCOHERENT SUBTRACTIONS IN PRODUCTION PROCESSES FROM NUCLEI. Trefil, J. S. (Univ. of Illinois, Urbana). Nucl. Phys., B11: 330-8(1969).

The question of the contribution of incoherent events to small angle nuclear production cross sections is discussed. It is shown that the correct treatment of such events can be important in the determination of unstable particle-nucleon cross sections. The examples of vector meson photoproduction and elastic scattering are calculated. (auth)

36872 VECTOR MESON DOMINANCE AND THE MAGNETIC MOMENT OF THE ρ MESON. Banyai, L.; Rittenberg, V. (Inst. of Physics, Bucharest). Rev. Roum. Phys., 14: 111-12(1969).

It is pointed out that the magnetic moment of the ρ meson predicted by the vector meson dominance hypothesis agrees surprisingly well with that obtainable from the simple quark picture. (L.B.S.)

36873 S-MATRIX THEORY OF ELECTROMAGNETIC INTERACTIONS. Vrejoiu, C.; Burlacu, L.; Nicolescu, B. (Univ. of Bucharest). Rev. Roum. Phys., 14: 7-15(1969).

The electromagnetic vertex $e\gamma \to e$ is evaluated using the formalism of the S-matrix theory. The identity between this calculation and those of the conventional quantum electrodynamics is obtained through the suitable choosing of the subtraction constants. (auth)

36874 ELECTROMAGNETIC NUCLEON FORM FACTORS IN THE SPACELIKE ASYMPTOTIC REGION. Ruehl, W. (CERN, Geneva). Nucl. Phys., B11: 505-13(1969).

An O (3,1) analysis of current matrix elements is applied to the electromagnetic current between single-nucleon states. The asymptotic behavior of the form factors is described in terms of singularities of two reduced vertex functions. In particular poles and cuts are considered. (auth)

36875 ON POLARIZATION EFFECTS IN COMPTON SCATTERING ON RELATIVISTIC ELECTRONS. Goldman, I. I.; Khoze, V. A. (Erevan Physical Inst.). Phys. Lett., 29B: 426-7(June 23, 1969).

The polarization properties of γ-quanta, produced in Compton scattering of laser photons by relativistic electrons are discussed. Besides, the expressions are derived for the polarization parameters of photons, emitted in the scattering of a very intense wave by electrons. (auth)

36876 DISPERSION ANALYSIS OF PION PHOTOPRODUCTION FROM NUCLEONS. II. Jurewicz, A. (Univ., Rome). Z. Phys., 224: 432-45(1969).

An account is given of numerical results for $l = 0$ and $l = 1$ multipole amplitudes of pion photoproduction. They were obtained by solving integral equations which originate from fixed angle dispersion relations that were deduced previously. Solutions of truncated integral equations for photoproduction amplitudes, are presented which take into account coupling with the most important transitions $M_{1+}^{(3)}$ (in the isovector case) and $E_{0+}^{(0)}$ (in the isoscalar case). Implications of such an approach, are discussed, and a comparison of results obtained by a different method is made. (auth)

36877 POWER AND INTENSITY OF RADIATION OF A RELATIVISTIC PARTICLE. Mychelkin, E. G. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat., No. 4, 23-8(July-Aug. 1968). (In Russian).

The transformation properties of power and intensity of radiation of a relativistic particle and limitations which apply to the use of the quantities in the special theory of relativity are considered. The main conclusions were illustrated using the example of the classical problem concerning the radiation of a charge moving in a magnetic field along a cylindrical spiral. (tr-auth)

36878 METHOD FOR ELIMINATION OF ACCIDENTAL MEASUREMENT ERRORS. Voinov, V. G. Izv. Akad. Nauk

Kaz. SSR, Ser. Fiz.-Mat., No. 4, 61-6(July-Aug. 1968). (In Russian).

The method of elimination of accidental errors was analyzed based on the correlation properties of the first or second differences of measured quantities. For example, the determination of the curvature of a charged particle track and its repeated scattering in nuclear photoemulsion showed that with the proposed method it is possible essentially to reduce the effect of accidental errors. The method described can be used for the study of various physical quantities if their correlation properties are known beforehand. (tr-auth)

36879 CONCERNING MASS SPLITTING IN ISOMULTIPLETS OF PSEUDOSCALAR MESONS. Chkareuli, Dzh. L. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.), 9: 334-7(May 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 548-52(May 5, 1969).

The radiative corrections to the masses of the pseudoscalar mesons are calculated to the order to e^2 in the Lagrangian theory with transverse vector fields. (J.F.P.)

36880 PHOTOPRODUCTION OF COMPOSITE PARTICLES. ASYMPTOTIC BEHAVIOR OF SOME MODELS. Barbieri, R. (Scuola Normale Superiore, Pisa, Italy). Phys. Rev., 181: 2117-23(May 25, 1969).

The photoproduction amplitude of a spinless composite particle is examined in some models. The asymptotic behavior of such an amplitude and the related problem of fixed singularities in the angular momentum plane are studied. By means of the Bethe–Salpeter wave function for the compound vertex and of the Deser–Gilbert–Sudarshan–Ida spectral representation for this wave function, it is shown how compositeness of the particle produced removes the fixed pole at J = 0 in the crossed-channel partial-wave amplitudes. (auth)

36881 POMERANCHUK EXCHANGE AND LOW-ENERGY THEOREMS IN COMPTON SCATTERING. Arbab, Farzam (Brookhaven National Lab., Upton, N. Y.); Brower, Richard C. Phys. Rev., 181: 2124-9(May 25, 1969).

The method, introduced in a previous work, of deriving the kinematical properties of zero-mass bosons from the limit of a theory with massive particles is here applied to the problem of Compton scattering. It is shown that the same mechanism that eliminates the factor of $\alpha_\gamma(t)$ from the nonsense amplitude in pion photoproduction processes and allows the pion pole to occur in such amplitudes also removes the nonsense factor of $\alpha_P - 1$ from the residue of the Pomeranchuk trajectory in Compton scattering. This allows the Pomeranchuk exchange to contribute to the photoabsorption total cross section. The connection of this result with the vector-dominance model is discussed. A short derivation of the low-energy theorems for Compton scattering using this limiting procedure is also given. (auth)

36882 EXACT DETERMINATION OF THE COULOMB AMPLITUDE BY S-MATRIX METHODS. Artru, X.; Fontannaz, M.; Omnes, R. (Faculte des Sciences, Orsay, France). Phys. Rev., 181: 2130-40(May 25, 1969).

An extension of the S-matrix methods to the case of the exchange of zero-mass particles allows the Coulomb scattering amplitude and the levels of the hydrogen atom to be determined completely. Starting from special analytic properties in t due to the zero mass of the photon, the amplitude is written as an entire function of ln t. Two of the main assumptions are: (1) The amplitude is of exponential type with respect to ln t; (2) the partial-wave amplitude has only Regge poles in l. Several classes of solutions are found. One of them is the Schrödinger solution. The others lead to ghosts or to bound states in the e^+p system and are therefore discarded. The same method can be extended to the nonrelativistic problem with spin, and leads to the same result as in the case without spin. In the relativistic case, results are obtained which disagree with the Dirac and Klein–Gordon solutions. (auth)

36883 DOES THE ELECTROMAGNETIC CURRENT HAVE A UNITARY SINGLET COMPONENT? Mathur, V. S.; Okubo, S. (Univ. of Rochester, N. Y.). Phys. Rev., 181: 2148(May 25, 1969).

A possibility that the electromagnetic current may have a unitary singlet component has been investigated in connection with $V_\beta \to l\bar{l}$ decays. The Maki-Hara model of elementary particles seems to be experimentally ruled out. As for the three-triplet model, it has been pointed out that we must have additional 1^- vector mesons ρ', ω', and ϕ' with nonzero charm quantum numbers in order to saturate a new sum rule. (auth)

36884 HIGH-ENERGY PHOTOPRODUCTION OF ρ^0 AND ϕ MESONS: A COMPOSITE VIEW OF VECTOR MESONS. Kramer, G.; Uretsky, J. L. (Argonne National Lab., Ill.). Phys. Rev., 181: 1918-26(May 25, 1969).

A model of high-energy ρ^0- and ϕ-meson photoproduction is constructed in which the incident photon produces a charged pion (kaon) pair near the target. The photon coupling to the meson pair is just the electric charge e. A virtual meson undergoes diffraction scattering from the target and the ρ^0 (ϕ) is seen as a final-state interaction of the meson pair. There are no free parameters in the model. Agreement with presently existing high-energy experiments is quite good. (auth)

36885 CHIRAL LAGRANGIAN MODEL OF SINGLE-PION PHOTOPRODUCTION. Peccei, R. D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 181: 1902-5(May 25, 1969).

A chiral-invariant Lagrangian model was constructed for single pion photoproduction. This Lagrangian was used to calculate threshold values for the differential cross sections. These threshold results were found to be in reasonable agreement with recent current-algebra calculations. For the cases where data were available, the comparison with experiment was favorable. (auth)

36886 REGGE POLES AND AN S-MATRIX THEORY OF THE LAMB SHIFT. McEnnan, James (Univ. of Florida, Gainesville). Phys. Rev., 181: 1967-71(May 25, 1969).

The Lamb shift in hydrogen is calculated by means of dispersion theory. Relativistic invariance is maintained throughout the calculation, and electron spin is included, although the spin of the proton is neglected. Divergence problems which have plagued other calculations are eliminated by the exploitation of the Regge behavior of the amplitudes which appear in the dispersion integrals. The preliminary results are in excellent agreement with the lowest-order values given by Yennie and Erickson. (auth)

36887 ON J-PLANE SINGULARITIES OF $e^-\mu^-$ SCATTERING AMPLITUDES. Gorshkov, V. G.; Lipatov, L. N.; Nesterov, M. M. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 9: 1221-31(June 1969). (In Russian).

Double logarithmic asymptotics is obtained for s-antisymmetrical part of the $e^- e^+ \to \mu^- \mu^+$ backward annihilation amplitude. It is shown that the u-channel partial wave with negative signature has a logarithmic singularity in the J plane to the right of the singularities of the partial wave with positive signature. Therefore the asymptotics of the amplitude at high energies is the asymptotics of its antisymmetrical part. (auth)

36888 DETERMINATION OF THE ELECTROMAGNETIC FORM FACTOR IN THE SPACE-LIKE REGION FROM THE VALUE OF ITS MODULUS IN THE TIME-LIKE REGION. Geshkenbein, B. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1232-5(June 1969). (In Russian).

A problem of determination of the π-meson electromagnetic form factor $F(q^2)$ in the whole complex region from the value of its modulus in the time-like region is solved. If the form factor $F(q^2)$ has no zeroes in the complex plane it is determined uniquely. If the form factor has zeroes in the complex plane it is determined up to the factor of a certain type. In this case the restrictions on the asymptotic behavior of the form factor $F(q^2)$, on the π-meson radius as well as the restrictions from above on the values of the form factor in the whole space-like region are obtained. (auth)

36889 A CONTRIBUTION TO THE PROBLEM OF ELECTRON AND MUON PAIR PRODUCTION BY COSMIC-RAY MUONS. Kel'ner, S. R.; Kotov, Yu. D. (Moscow Engineering-Physics Inst.). Yadern. Fiz., 9: 1210-11(June 1969). (In Russian).

Energy spectra of electron-positron and muon pairs produced by cosmic ray muons, are obtained. It is shown that as a result of the decreasing spectrum of the cosmic ray muons the probability to produce a muon pair does not differ essentially from that for an electron-positron pair. (auth)

36890 DOUBLE-LOGARITHM ASYMPTOTICS OF THE $e^+e^- \to 3\gamma$ ANNIHILATION. Terent'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1212-20(June 1969). (In Russian).

Differential cross section of the process $e^+e^- \to 3\gamma$ (1) is calculated with account of all the orders in the parameter α $\ln^2 s$ ($\alpha = 1/137$, $s = 4\epsilon^2$ – total c.m. energy squared). The double-logarithm corrections are substantial at the c.m. energies $\epsilon \gtrsim$ 10 GeV when the experimental investigation of the process (1) is of interest to test the linearity of the basic quantum electrodynamical equations. (auth)

Weak

Refer also to abstract 36972.

36891 (NYO-2171-277) UNCONVENTIONAL MODELS OF WEAK INTERACTIONS. Segre, Gino (Pennsylvania Univ., Philadelphia). July 1969. 42p. Dep. CFSTI.

Renormalizable and nonrenormalizable models of weak interactions are considered. This whole series of models discussed agrees with the simple phenomenological interaction but differ from it when calculations are performed to higher order in G_F, when it becomes necessary to the behavior for all momentum transfers. (J.F.P.)

36892 DIVERGENCES OF SECOND CLASS VECTOR CURRENTS. Eliezer, Sh.; Singer, P. (Technion-Israel Inst. of Tech., Haifa). Nucl. Phys., B11: 514-20(1969).

Assuming the divergence of the strangeness conserving vector current to be proportional to a scalar field, Treiman-Goldberger-like relations are obtained. Using these relations with the parameters of the π_N scalar-isovector meson, the second-class vector contributions to η and Σ leptonic decays are estimated and it is found that they are of the same order of magnitude as electromagnetic corrections. (auth)

36893 μ-e RATIO FOR SEMI-LEPTONIC HYPERON DECAYS. Schroeder, U. E. (Univ., Frankfurt am Main). Nucl. Phys., B11: 595-600(1969).

The μ-e ratio for semi-leptonic hyperon decays is computed taking into account the q^2-dependence of all form factors induced by regular currents. The results are discussed for the decays $\Sigma^- \to n + l^- + \bar{\nu}_l$, $\Lambda \to p + l^- + \bar{\nu}_l$ and $\Xi^- \to \Lambda + l^- + \bar{\nu}_l$. They are in good agreement with the experimental data known at present. (auth)

36894 POSSIBILITY OF NON-OCTET AXIAL-VECTOR CURRENTS. Pakvasa, S. (Univ. of Hawaii, Honolulu); McDonald, A.; Rosen, S. P. Phys. Rev., 181: 1948-55(May 25, 1969).

Three models of axial-vector currents which contain both octet and non-octet components are examined. The first model is based upon the $\Delta U = 1/2$ rule, and it forbids decays with $\Delta S = -\Delta Q$ and $\Delta S = 2$. The second model conserves a "weak hypercharge," and introduces $\Delta S = -\Delta Q$ and $\Delta S = 2$ terms in a specific way. The third model assumes that the usual $\Delta T = 1$ and $\Delta T = 1/2$ rules are valid even when the octet rule is not. Although present data on semileptonic hyperon decay are not accurate enough to determine the precise admixture of non-octet components, they seem to indicate that such currents are restricted to the 27 representation, and that they may form about 10% of the total current. Throughout the discussion the conserved-vector-current hypothesis is assumed to hold. Some of the general theoretical consequences that would follow from the existence of non-octet axial-vector currents are also considered. (auth)

36895 EFFECTIVE-HAMILTONIAN APPROACH TO HYPERON BETA DECAY. Watson, J. M.; Winston, R. (Univ. of Chicago). Phys. Rev., 181: 1907-8(May 25, 1969). (COO-1701-5).

Our approach to hyperon β decay is to restrict the theory, from the beginning, to the first order in the velocity of the recoil nucleon. The resulting effective Hamiltonian leads to an approximation which displays the physical content of the theory more explicitly than the exact expressions, through a simple form already familiar from neutron β decay. Assuming the current-current form of the weak interaction and a V-A lepton current, the most general hadron current is used, and the weak magnetism and pseudotensor terms are retained. Correlation coefficients are obtained for the decay angular distribution of polarized hyperons which are in close agreement with the exact theory. (auth)

36896 MEASUREMENT OF THE LOW-ENERGY END OF THE μ^+ DECAY SPECTRUM. Derenzo, Stephen E. (Univ. of Chicago). Contract Nonr-2121(25) Phys. Rev., 181: 1854-66(May 25, 1969).

The μ^+ decay spectrum was measured below 6.8 MeV/c using a hydrogen bubble chamber. The chamber was calibrated as an electron spectrometer using the 0.9- and the 1.4-MeV/c internal conversion lines from a ^{207}Bi source. When the measured distribution was fitted to the Michel spectrum, the low-energy parameter η was found to be -0.13 ± 0.20, with ρ constrained to be 3/4. A two-parameter fit incorporating published data from spark-chamber measurements of the upper half of the spectrum gave the values $\eta = -0.12 \pm 0.21$ and $\rho = 0.752 \pm 0.003$. (auth)

36897 CABIBBO THEORY, POLE DOMINANCE, AND SUM RULES FOR RADIATIVE DECAYS OF PSEUDOSCALAR MESONS. Intemann, Gerald W. (State Univ. of New York, Binghamton). Phys. Rev., 181: 1866-74(May 25, 1969).

By extending the Cabibbo theory to the radiative leptonic decay $\pi^+ \to \pi^0 + l^+ + \nu_l + \gamma$, the vector and axial-vector form factors which describe this decay are analyzed. Assuming unsubtracted dispersion relations for these form factors at fixed momentum transfer as well as pole dominance, a number of sum rules relating the masses and couplings of the ω, ρ, A_1, and A_2 mesons are obtained. In addition, using current algebra and the hypothesis of a partially conserved axial-vector current, a soft-pion theorem relating the vector form factors of the decay $\pi^+ \to \pi^0 + l^+ + \nu_l + \gamma$ to the axial-vector form factor associated with $\pi^+ \to l^+ + \nu_l + \gamma$ is obtained. For those sum rules that can be tested, excellent agreement is obtained with the experimental data. A similar analysis is made of the decay $K^+ \to \pi^0 + l^+ + \nu_l + \gamma$, and a corresponding set of sum rules is obtained relating the masses and couplings of the ω, K^*, K_V, and K_A mesons. (auth)

36898 VECTOR DOMINANCE AND THE K_{l4} VECTOR FORM FACTOR. Wood, L. E. (Univ. of Maryland, College Park). Phys. Rev., 181: 1890-2(May 25, 1969).

The K_{l4} vector form factor is estimated using Sakurai's vector-dominance model. For the first time, all lowest-order Feynman graphs which contribute to the process have been included. The vector form factor is found to be between -0.96 and -1.4, depending on the methods and experimental numbers used. Comparisons with previous estimates and present experimental data are made. (auth)

36899 MODEL OF WEAK INTERACTIONS WITH A 300-BeV CUTOFF. Segre, Gino (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 181: 1996-2006(May 25, 1969).

A model of weak interactions is displayed which preserves all the observed symmetries of weak interactions in lowest order. It is mediated by three intermediate vector bosons with their respective antiparticles, and also contains a massive neutral muon-type lepton and electron-type lepton, so altogether there are two lepton triplets: e, ν_e, λ_e and μ, ν_μ, λ_μ. Higher-order corrections diverge, but for a cutoff $\Lambda \sim 300$ BeV, i.e., $G_F \Lambda^2 \sim 1$, the model is shown to be compatible with present experimental limits. (auth)

Strong (General)

36900 (JINR-P2-4267) ANTIQUARKS IN THE UNIVERSE. Sakharov, A. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 16p. (In Russian). Dep.

A hypothesis on the existence of stable electrically neutral antiquarks with an average cosmic density, corresponding to the baryon neutrality of the universe, was suggested. The antiquarks, under this hypothesis, are not captured by nuclei but have noticeable scattering cross section. The existence of particles with the mentioned properties is connected with the hypothesis of the cosmologic CPT symmetry and with the three-triplet quark model. (auth)

36901 (JINR-P2-4543) MUON PAIR PRODUCTION IN STRONG INTERACTIONS AND THE ASYMPTOTIC SUM RULES. Matveev, V. A.; Muradyan, R. M.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 23p. (In Russian). Dep.

The process of muon pair production in the deep inelastic collision of two hadrons is considered. The sum rules were obtained combining the limiting values of form factors with the matrix elements of equal-time commutators of the electromagnetic currents. (auth)

36902 UNSTABLE PARTICLES IN THE LEE MODEL. Chan, Vu Duy (Lab. of Physical Mathematics, Paris). Nucl. Phys., B11: 293-308(1969). (In French).

The "N + θ" resonance through V is defined mathematically by the existence of the "unique couple" (z_0, x_{z_0}): z_0 is the eigenvalue of the Hamiltonian in the Riemann second sheet, near the cut (μ, ∞) and x_{z_0} the corresponding eigenvector in X_{II}, when the couing $g_0 \ll 1$. (auth)

36903 QUARKS OF ALMOST ANY SPIN. Franklin, Jerrold (Temple Univ., Philadelphia). Phys. Rev., 181: 1984-8(May 25, 1969).

Quark-model predictions are investigated for quarks of any half-integral spin. While quarks of spin 1/2 must obey effective Bose statistics if they are to be in space-symmetric states, it is shown that quarks of spin greater than 1/2 can obey either Fermi or Bose statistics. The generalization to quarks of any half-integral spin leads to essentially the same conclusions previously found for spin-3/2 Fermi quarks. The quark-model predictions so far tested depend very little on the spin or statistics of quarks, but a measurement of the magnetic moment of the Ξ^- or Ω^- hyperon would test the spin and statistics of quarks. (auth)

36904 COMMENTS ON QUASARS AND QUARKS. Skutnik, B. J. (Brandeis Univ., Waltham, Mass.). Phys. Rev., 181: 2145-6(May 25, 1969).

Several points in connection with the recent paper by Huang and Edwards are noted. First, extraterrestial spectroscopic searches for quarks have been carried out since 1966 by several groups. Secondly, because of the crudeness of the available data, the criteria used for the identifications were not sufficient and thus it should be stressed that the assignments are quite tentative. Thirdly, order-of-magnitude estimates of relative abundances of the quarked species were not made, based on the identifications. Finally, several of the transition lines identified as λ_{Q1} or λ_{Q2} should have had related normal species $\lambda_{Q\phi}$ in the visible region, yet the related $\lambda_{Q\phi}$'s were not present except in one case. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 36960.

36905 (COO-1428-126) REVIEW OF EXPERIMENTAL METHODS OF ANALYSIS OF $\pi\pi$ SCATTERING AND A UNIQUE SET OF δ_l^I. Gutay, L. J. (Purdue Univ., Lafayette, Ind.). May 1969. Contract AT(11-1)-1428. 43p. (CONF-690521-3). Dep. CFSTI.

From Conference on the π-π and K-π Interactions, Argonne, Ill.

The theoretical concepts involved in the extraction of $\pi\pi$ scattering from the reaction $\pi + N \rightarrow N + \pi + \pi$ are discussed, and the analysis of a number of experiments which studied the $\pi\pi$ interaction at a dipion effective mass of less than one GeV is reviewed. The theoretical assumptions that these analyses have in common are emphasized, and it is shown that a unique set can be chosen. The $\pi\pi$ scattering on the mass shell, the relation between πN inelastic scattering and elastic $\pi\pi$ scattering, partial wave decomposition, and experimental methods for the determination of δ_l^I and ambiguities in this determination are discussed. It is concluded that there is an S-wave $\pi\pi$ resonance with $\sqrt{s_0} \approx 0.72$ GeV and $\Gamma \sim 140$ MeV. The factorization and extrapolation models give consistent answers. (J.F.P.)

36906 MESON PRODUCTION CHIRAL SU(3) ⊗ SU(3) PHENOMENOLOGICAL LAGRANGIANS. Turner, Leaf (Univ. of Wisconsin, Madison). Nucl. Phys., B11: 355-72(1969).

In order to obtain a general chiral SU(3) ⊗ SU(3) phenomenological Lagrangian, Weinberg's covariant derivative technique is generalized for multiple soft-pion processes. Using this Lagrangian, meson-meson and meson-baryon scattering, as well as single meson production (PB → PPB) are described. It is noted that this model gives the well-known, completely specified current algebra predictions of π-N and K-N scattering. In contrast, it is shown that all the mass-shell amplitudes for meson-meson scattering and single meson production depend on a single unknown parameter ξ. An analysis of the single pion production data indicates that $-1 \lesssim \xi \lesssim 0$, in accordance with Weinberg's formulation of π-π scattering. The usefulness of the model in explaining the double pion production process, $\pi^- p \rightarrow \pi^+\pi^-\pi^- p$, is explored. (auth)

36907 ANOMALOUS NEARBY SINGULARITIES IN VERTEX FUNCTIONS AND CURRENT ALGEBRA. Gaifi, L.; Kuti, J. (Roland Eoetvoes Univ., Budapest). Nucl. Phys., B11: 286-92 (1969).

A technique is presented to calculate the anomalous nearby singularities in vertex functions composed of the isotopic vector and axial-vector currents. A special model shows that the pole-dominance hypothesis should be revised by basing the related smoothness assumption for proper vertices not on pure intuition, but on physical criteria. (auth)

36908 STRONG DECAYS ($V \rightarrow \varphi_1 + \varphi_2$) IN BROKEN CHIRAL SYMMETRY. Bose, S. K. (Indian Inst. of Tech., Kanpur). Nuovo Cim., Lett., 2: 22-4(July 1, 1969).

The strong decay of a vector meson into two pseudoscalar mesons is studied in the framework of broken chiral SU(3) × SU(3) symmetry. The decay width and branching ratios for $\rho \rightarrow \pi + \pi$, $\phi \rightarrow K + \bar{K}$, and $K^* \rightarrow \pi + K$ are obtained. (L.B.S.)

36909 LINK BETWEEN f_K/f_π AND THE MASS OF A STRANGE SCALAR MESON. Denardo, G. (Univ., Trieste, Italy); Napolitano, E.; Soliani, G. Nuovo Cim., Lett., 2: 36-40(July 1, 1969).

An attempt is made to obtain information of the K-π scattering amplitude and a consistent relation between the ratio f_K/f_π and the mass of a strange scalar meson, from the combined use of current algebra commutation relations and field theory model commutators. (L.B.S.)

36910 SU_3 SELECTION RULE FROM THE VENEZIANO MODEL. Frampton, P. H. (Univ. of Chicago); Michael, C. Nuovo Cim., Lett., 2: 81-3(July 21, 1969).

It is pointed out that the measurement of the decay width for $A_{2L} \rightarrow \eta\pi$ will indicate the importance of nonleading terms in Veneziano's formula. It is also shown how the particular SU(3) selection rule which forbids the decay $A_{2L} \rightarrow \eta\pi$ may be obtained from the leading-term Veneziano ansatz for $\pi\eta \rightarrow \pi\eta$ together with SU(3) mass degeneracy. (L.B.S.)

36911 πK SCATTERING LENGTH AND THE BACKGROUND TERM IN THE VENEZIANO MODEL. Kiang, D.; Kwok, P. Y.; Nakazawa, K. (Dalhousie Univ., Halifax, Nova Scotia). Nuovo Cim., Lett., 2: 84-6(July 21, 1969).

The necessity of taking into account the background term of the Veneziano amplitude for πK interactions is pointed out. (L.B.S.)

36912 GROSS FEATURES OF THE ANNIHILATION PROCESS $p\bar{p} \rightarrow n\pi$. Muirhead, H.; Poppleton, A. (Univ. of Liverpool). Phys. Lett., 29B: 448-50(June 23, 1969).

The behavior of the mean square of the matrix element for proton-antiproton annihilation to multipion systems was examined with the aid of the experimental data. A simple dependence on the parameter s (the square of the energy in the c-system) is found which is independent of multiplicity. (auth)

36913 PADE APPROXIMATION IN THE σ MODEL UNITARY $\pi\pi$ AMPLITUDES WITH THE CURRENT ALGEBRA CONSTRAINTS. Basdevant, J. L.; Lee, B. W. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France. Laboratoire de Physique Theorique et Hautes Energies, Orsay, France. CNRS, Orsay, France). Phys. Lett., 29B: 437-41(June 23, 1969).

The $\pi\pi$ scattering is considered in the σ-model renormalized in a way which preserves explicitly the PCAC condition. The Padé approximation to the partial wave amplitudes is constructed and exact unitarity is obtained. The theory contains one parameter and generates all features of low energy $\pi\pi$ scattering in the s, p and d-waves. (auth)

36914 HELICITY STATES OF BOSON RESONANCES DECAYING INTO TWO IDENTICAL VECTOR OR PSEUDOVECTOR BOSONS. Krasznovszky, Sandor. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 17: 87-91(1969). (In Hungarian).

Helicity states are described for boson resonances decaying into two identical vector or pseudovector bosons. In terms of these states a uniform method is given for the determination of the rigorous selection rules for a boson resonance decaying into two identical bosons of arbitrary spin and parity. On applying the Bose-Einstein statistics, the method yields a rule for the isospins, as well. (auth)

36915 MASS ESTIMATE AND DECAY MODES AND ENERGIES OF SCALAR AND VECTOR MESONS. Akulov, N. S.; Kovalenko, A. I. (Physical-Technical Inst., Kazan). Dokl. Akad. Nauk BSSR, 13: 206-9(Mar. 1969). (In Russian).

On the basis of the unified corpuscular field (rheon) elementary particle theories are considered for scalar and vector mesons, for estimates of masses and decay energies, in which difficulties are encountered in the Heisenberg unified field theory. It is considered that in successive decay modes with increasing decay energies $Q_1 < Q_2 < Q_3$, initial decays are stipulated by the annihilation of most unstable structural components of mesons, which do not appear in the decay products. The method for their identification is made more precise, and it is established that there are contained in the π, ω, and ϕ resonances the same saturated unstable components which consist of heavy leptons, in particular heavy muonium $\mu^- e_1^+ = \pi_1^0$, which were discovered previously in kaons and hyperons. From the calculation of the unstable component an estimate of masses and the decay modes and energies of the π, ϕ, ω, and η mesons is given in quantitative agreement. (tr-auth)

36916 ELECTRODYNAMICS OF VECTOR MESONS. Grant, C. T. (Lehigh Univ., Bethlehem, Pa.). Phys. Rev., 181: 2064-5 (May 25, 1969).

Starting from the Lagrangian density for a vector meson suggested by Wellner, the second-order self-energy part of the photon and the lowest-order corrections to the single-photon vertex are investigated. To renormalize the former diagram, it is required that the meson have a nonzero electric dipole moment and no anomalous magnetic moment. When the method is extended to the vertex parts, there remain certain logarithmically divergent terms which appear to be nonrenormalizable. (auth)

36917 VENEZIANO REPRESENTATION WITH THE POMERANCHUK TRAJECTORY. Wong, David Y. (Univ. of California, San Diego, La Jolla). Phys. Rev., 181: 1900-1(May 25, 1969).

A term containing the Pomeranchuk trajectory is constructed for the Veneziano representation of the $\pi\pi$ scattering amplitudes. It contributes to direct-channel resonances (recurrences of P) only in the I = 0 amplitude and gives proper asymptotic behavior for all isospin amplitudes. Taking the same slope as the ρ trajectory and normalizing to the asymptotic cross section of 15 mb, an I = 0, J = 2 resonance at 1 BeV with a width of 75 MeV is obtained. The Adler condition is satisfied, and the contribution of the Pomeranchuk term to the scattering lengths is very small. (auth)

36918 AN I = 1 $\pi\pi$ SUM RULE AND THE DERIVATIVES OF THE S-WAVE $\pi\pi$ AMPLITUDES. Chu, Shu-yuan; Desai, B. R. (Univ. of California, Berkeley. Univ. of California, Riverside). Contracts AT(11-1)34 P107A; W-7405-Eng-48. Phys. Rev., 181: 1905-6(May 25, 1969).

A sum rule for the I = 1 $\pi\pi$ amplitude is written at the symmetry point, $s = t = u = \frac{4}{3}m_\pi^2$, under the assumption that $\partial A^1(t,V)/\partial V$ satisfies an unsubtracted fixed-t dispersion relation, where t and V are the energy and momentum-transfer variables. From the symmetry-point conditions, $\partial A^0/\partial t$ and $\partial A^2/\partial t$ are obtained and compared with the current-algebra estimates. (auth)

36919 DIVERGENT VERTICES AND WARD IDENTITIES. Wilson, Kenneth G. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 181: 1909-13(May 25, 1969).

Schwinger and Adler have discovered that if the A_1-ω-ρ off-shell vertex function is linearly divergent, then the axial-vector Ward identity for the A_1-ω-ρ vertex contains an extra model-dependent term. It is shown here that no extra term occurs in the Ward identities for the A_1-ρ-π system when the A_1-A_1-ρ vertex is linearly divergent. (auth)

36920 CERTAIN IMPLICATIONS FOR HIGH-ENERGY TOTAL CROSS SECTIONS FROM THE MULTIPERIPHERAL MODEL. Ting, Peter D. (Univ. of California, Berkeley). Phys. Rev., 181: 1942-5(May 25, 1969).

The multiperipheral model is used to relate the experimental fact, $\sigma_{N\bar{N}}^{tot} > \sigma_{NN}^{tot}$, to the possibility that the $N\bar{N}$ channel can annihilate into purely meson final states by exchange of N or $\bar{N}$ trajectories, whereas the NN channel cannot do so. The argument shows that from the multi-Regge bootstrap point of view, the combination of baryon and antibaryon trajectories will generate a pair of exchange-degenerate trajectories P′ and ω. The same line of reasoning can easily be generalized to include strange particles, as well as the (K^-N, K^+N) and (π^-p, π^+p) systems. (auth)

36921 ELEMENTARY-PARTICLE POLES IN THE BETHE–SALPETER EQUATION. Haymaker, Richard W. (Univ. of California, Santa Barbara). Phys. Rev., 181: 2040-4(May 25, 1969).

An elementary spin-zero particle pole is inserted in the Bethe–Salpeter equation. This gives a non-Regge δ_{10} term in the potential and the scattering amplitude. Methods are presented for calculating the l = 0 partial-wave amplitude with emphasis on finding the pole positions. Our methods are tested with a ladder-approximation example. Finally, the renormalization constants Z_1 and Z_3′ of the elementary particle are discussed and it is shown how the vanishing of these constants is related to bootstrap conditions. (auth)

36922 EFFECTS OF THE FINITE WIDTH OF THE ρ MESON ON SOME VECTOR-MESON-DOMINANCE PREDICTIONS. Gounaris, G. J. (Univ. of Chicago). Phys. Rev., 181: 2066-77 (May 25, 1969).

Corrections due to the finite width of the ρ meson based on a generalized effective-range formula for pion-pion scattering modify by a non-negligible amount the well-known expressions, based on vector-meson dominance, for the following branching ratios: $\Gamma(\rho^0 \to e^+e^-)/\Gamma(\rho^0 \to \pi^+\pi^-)$, $\Gamma(\varphi \to K\bar{K})/\Gamma(\rho^0 \to \pi^+\pi^-)$, $\Gamma(\omega \to e^+e^-)/\Gamma(\rho^0 \to e^+e^-)$, and $\Gamma(\varphi \to e^+e^-)/\Gamma(\rho^0 \to e^+e^-)$. A new current-algebra prediction for the shape and magnitude of $\sigma_{tot}(e^+e^- \to \pi^+\pi^-)$ is presented, and the ρ-meson contribution to the Schwinger term and to the anomalous magnetic moment of the muon is estimated. A discussion of ρ dominance when the width is explicitly taken into account and a simple recipe for including finite-ρ-width corrections in vector-meson-dominance calculations are also given. (auth)

36923 CURRENT ALGEBRA, $\pi\pi$ SCATTERING, AND THE ρ LEPTONIC-DECAY BRANCHING RATIO. Levin, David N. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 181: 2083-7 (May 25, 1969).

Following Weinberg, use is made of linearity, current algebra, and the hypothesis of partially conserved axial-vector current to restrict the form of the $\pi\pi$ amplitude below threshold. However, isoscalarity of the σ term is not assumed. Instead, a model is proposed in which nonpole scattering diagrams are constant below threshold. Then, the current-algebra restriction leads to a consistency condition from which the ρ leptonic-decay branching ratio can be calculated. The prediction is $B(l^+l^-) \approx (0.68 \pm 0.18) \times 10^{-4}$. This agrees well with recent experimental data: $B(e^+e^-)_{expt} = (0.56 \pm 0.06) \times 10^{-4}$, $B(\mu^+\mu^-)_{expt} = (0.66 \pm 0.15) \times 10^{-4}$. In addition, the $\pi\pi$ scattering lengths are determined to be in agreement or nearly in agreement with Weinberg's. The model suggests that the small scattering lengths result from a cancellation of large nonpole and ϵ-exchange contributions. (auth)

36924 COMPLEX-l-PLANE SINGULARITIES IN THE VENEZIANO FORMULA. Drago, Francesco; Matsuda, Satoshi (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 181: 2095-7(May 25, 1969).

The continued partial-wave projection of the Veneziano formula is performed and the complex-l-plane singularities are investigated. It is explicitly shown that in the $\pi\pi$ amplitudes given by the Veneziano-Lovelace model there are an infinite series of Regge poles with parallel trajectories spaced by one unit and an essential singularity as $\mathrm{Re}\, l \to -\infty$. For the even-signature amplitude, besides the singularities mentioned above, additive fixed poles are shown to be present at nonsense wrong-signature points. The classification of the Regge-pole family in terms of Lorentz poles and the positivity condition for the Regge-pole residues are also discussed. (auth)

36925 ONE-BOSON-EXCHANGE CONTRIBUTIONS TO HIGH-ENERGY $p-\bar{p}$ ELASTIC SCATTERING IN A NONLOCAL FIELD THEORY. Fassio-Canuto, L. (Goddard Space Flight Center, New York). Phys. Rev., 181: 1980-4(May 25, 1969).

The $p-\bar{p}$ elastic scattering in the GeV region is studied through the exchange of heavy bosons. Within the framework of a local field theory, the experimental results cannot be reproduced satisfactorily. Better agreement is obtained when suitable vertex functions representing a nonlocal Lagrangian are introduced. The fundamental length contained in the vertex function is found to be the nucleon Compton wavelength. (auth)

36926 SUGAWARA'S THEORY OF CURRENTS AND VECTOR MESONS. Kimel, I. (Univ. of Chicago). Phys. Rev., 181: 2152-4(May 25, 1969).

It is argued that recently proposed tests for Sugawara's theory of currents do not actually follow from the theory. The impossibility of having at the same time finite-c-number Schwinger terms for the vector currents and ω-φ mass mixing holds in that model also. Problems with the inclusion of the baryon-number current are pointed out. (auth)

36927 CONSISTENCY OF LOW-ENERGY PARAMETERS AND SOFT-PION SCATTERING THEORY. Olsson, M. G.; Turner, Leaf (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 181: 2141-2(May 25, 1969).

The parameters of low-energy $\pi\pi$, πN, and $\pi N \to \pi\pi N$ scattering and their consistency with current-algebra predictions are discussed. It is found that the isospin-zero $\pi\pi$ scattering length is $(0.24 \pm 0.03)m_\pi^{-1}$ quite independent of the exact value of f_π. An effective value of f_π near 85 MeV seems to be preferred. Experiments are suggested which will clarify the situation further. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 36840, 36906, and 36927.

36928 (INR-P-1047) PSEUDOSCALAR MESON PRODUCTION AND THE QUARK MODEL. Szeptycka, M.; Hofmokl, T. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 5p. Dep.

Predictions of the quark model are compared with the experimental data for the production of the pseudoscalar meson and a strong disagreement has been found for the π^0 and K^0 mesons. (auth)

36929 (JINR-E2-4479) ANGLE DISTRIBUTIONS AND POLARIZATIONS IN HIGH ENERGY PION-NUCLEON SCATTERING. Khrustalev, O. A.; Savrin, V. I.; Tyurin, N. E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 32p. Dep.

On the basis of the Schroedinger equation expressions for the scattering amplitudes, differential cross sections and polariza-

tions in the small and large angle elastic πN and charge-exchange scatterings are obtained. (auth)

36930 (KFKI-13/1969) A REMARK ON THE OBSERVATION OF S^0 MESON. Gemesy, T.; Suranyi, G. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). May 5, 1969. 3p. Dep.

In order to use the interaction $\pi^+ + n \rightarrow p + x^0$ to search for the S^0 meson one must rule out the possibility of the existence of a background channel which could give a bump as a kinematic effect in the $\pi^0\pi^0$ effective mass distribution at about 720 MeV. The channel in question having probably higher cross section than the S^0 at this energy is $\pi^+ + n \rightarrow N^{*+} + \pi^0 \rightarrow p + \pi^0 + \pi^0$. The effective mass distribution in this channel is calculated using the Stodolsky–Sakurai model. It is concluded that the $\pi^+ + n \rightarrow N^{*+} + \pi^0$ channel does not affect the observation of the S^0 resonance. (J.F.P.)

36931 (UH-511-49-69) EFFECT OF BACKGROUND ON THE $I = 2$ $\pi\pi$ SCATTERING PHASE SHIFTS. Stenger, V. J. (Hawaii Univ., Honolulu). May 28, 1969. Contract AT(04-3)-511. 9p. (CONF-690521-2). Dep. CFSTI.

From Conference on the π–π and K–π Interactions, Argonne, Ill.

Aspects of a model, in which pion-exchange and rho-exchange processes add incoherently, for the reaction $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + p$ at 3.9 GeV/c are discussed relevant to the $\pi\pi$ phase shift analysis. It is concluded that the background from other processes, in particular, other important pion-exchange processes, produces the major portion of the forward peaking effect. (J.F.P.)

36932 EVIDENCE FOR THE EXCHANGE ON THE ρ AND A_2 REGGE TRAJECTORIES IN THE REACTIONS $\pi^+p \rightarrow \pi^0\Delta^{++}$, $\pi^+p \rightarrow \eta^0\Delta^{++}$, AND $K^+p \rightarrow K^0\Delta^{++}$. Mathews, Robert D. (Univ. of California, Berkeley). Nucl. Phys., B11: 339-54(1969).

A study is made of three reactions involving Δ^{++} production, $\pi^+p \rightarrow \pi^0\Delta^{++}$, $\pi^+p \rightarrow \eta^0\Delta^{++}$ and $K^+p \rightarrow K^0\Delta^{++}$ which because of t-channel quantum number restrictions allow the exchange of only a few high-lying Regge trajectories. These trajectories are ρ, A_2 and $\rho + A_2$ respectively. In this respect these Δ production reactions are similar to the "elastic" reactions $\pi^-p \rightarrow \pi^0n$, $\pi^-p \rightarrow \eta^0n$ and $K^-p \rightarrow \bar{K}^0n$, which have the same Regge exchanges. Effective α plots for the ρ and A_2 trajectories are obtained from the Δ reaction data, which are consistent with those obtained from the "elastic" reactions. Differential cross sections for corresponding "elastic" and inelastic reactions are compared and the observation made that similar exchange particles yield similarly shaped differential cross sections. The reactions in which only the ρ contributes have narrow forward peaks, dips at $t \rightarrow -0.6$ and secondary maxima; those with A_2 exchanges have much broader distributions; and those with both ρ and A_2 exchanges have forward peaks of intermediate width. The intermediate character of the K reactions is consistent with SU(3), which would predict roughly equal proportions of ρ and A_2 exchange. Exchange degeneracy is also discussed, especially with regard to the remarkable experimental evidence that the decay correlations of the Δ^{++} appear to be the same in all three reactions. (auth)

36933 STRIP EQUATION IN PAGELS APPROXIMATION AND COMPOSITE NUCLEON. Roy, Salil (Indian Association for the Cultivation of Science, Jadavpur) Dasgupta, Padmanabha. Nucl. Phys., B11: 439-48(1969).

Pagels' method is adopted with some modification to solving the new strip-approximate N/D equations. The method is applied to generate the nucleon trajectory in the πN system from N, N*, and ρ exchanges in the crossed channels. Enormous simplification of the computational task could be achieved by replacing the Pagels pole fitting by Gaussian interpolation. Reasonable value of the nucleon mass and the slope of the trajectory has been obtained for a small range of values of the strip parameter. (auth)

36934 THE Ω^- TRAJECTORY IN A NEW STRIP APPROXIMATION. Roy, Salil (Indian Association for the Cultivation of Science, Jadavpur); Dasgupta, Padmanabha. Nucl. Phys., B11: 406-10(1969).

The $\bar{K}$-Ξ system is investigated in the new strip approximation, using the Pagels approximation to solve the strip N/D equations. The input dynamics include the exchange of Λ and Σ in the u-channel and the Ω^- Regge trajectory has been obtained. (auth)

36935 REGGE CUTS IN BACKWARD PION–NUCLEON SCATTERING. Odorico, R. (Univ., Trieste, Italy. Istituto di Fisica Nucleare, Trieste, Italy). Nuovo Cim., Lett., 2: 1-6 (July 1, 1969).

The difficulties associated with the simple baryon-exchange model of N_α and N_δ trajectories for describing new data on backward πp charge-exchange scattering and polarization are pointed out. Fixed-transfer dispersion relations are used to obtain some qualitative information on the high-energy structure of backward πp scattering. (L.B.S.)

36936 THE MESON–BARYON COUPLINGS AND SU_3-INVARIANCE. Pilkuhn, H.; Swoboda, A. (Univ., Karlsruhe, Ger.). Nuovo Cim., Lett., 1: 854-8(June 11, 1969).

Baryon decuplet widths and baryon octet couplings are investigated within the framework of SU(3) symmetry. (L.B.S.)

36937 NEED OF A $I = 3/2, J^P = 1/2^+$ PION–NUCLEON RESONANCE FOR THE SATURATION OF SUPER-CONVERGENCELIKE SUM RULES. D'Auria, R. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cim., Lett., 1: 904-7(June 11, 1969).

It is shown that consistency conditions require the existence of a $I = 3/2, J^P = 1/2^+$ pion-nucleon resonance for the saturation of super-convergence sum rules for pion scattering on nucleon and on other spin-$1/2$ pion-nucleon resonance. (L.B.S.)

36938 VENEZIANO MODEL AND BARYON PARTIAL WIDTHS. Amann, R. F. (Univ. of Chicago). Nuovo Cim., Lett., 2: 87-90(July 21, 1969).

Previous considerations of πN scattering have examined specific combinations of Veneziano terms. A more general approach is proposed which yields satisfactory fits to the resonances on the Δ and N_γ trajectories. (L.B.S.)

36939 REGGE POLE EXCHANGE ANALYSIS OF $K^+p \rightarrow K^{*0}\pi^+p$ AT 7.3 GeV/c. Chien, C. Y.; Malamud, E. I.; Mellema, D. J.; Rudnick, F. D.; Schlein, P. E.; Slater, W. E.; Stork, D. H.; Ticho, H. K.; Trippe, T. G. (Univ. of California, Los Angeles). Phys. Lett., 29B: 433-6(June 23, 1969).

A Regge pole exchange model is applied to the reaction $K^+p \rightarrow K^{*0}(890)\pi^+p$ at 7.3 GeV/c. The reaction is well described by exchanges of pion and Pomeranchuk trajectories with the Pomeranchuk exchange approximated by either a diffraction mechanism or on-mass shell π^+p scattering. The model fits the production of the Q enhancement and also gives an adequate description of the virtual π^+p scattering. (auth)

36940 ON THE MASS SPECTRUM OF BARYONS IN THE QUARK MODEL. Dushenko, V. F. (Kishinev Inst. of Mathematics). Ukr. Fiz. Zh., 14: 647-50(Apr. 1969). (In Russian).

The problem on eigenvalues and eigenfunctions for the relativistic equation of the three-quark model, drawn by P. N. Bogolyubov, is solved. The mass spectrum of baryons is obtained. (auth)

36941 DIPOLE MODEL OF THE A_2 MESON AND CHARGE-EXCHANGE SCATTERING AND POLARIZATION. Gajdicar, T. J.; Moffat, J. W. (Univ., Toronto). Phys. Rev., 181: 1875-7 (May 25, 1969).

The A_2 meson is described as a dipole resonance and a linear Regge-dipole A_2 trajectory is assumed to dominate the charge-exchange process $\pi^-p \rightarrow \eta n$. A least-squares fit to the differential cross-section data for four adjustable parameters is performed, and leads to a $\chi^2 = 11$ for 25 experimental points. A nonzero polarization is predicted. The multichannel problem corresponding to A_2 production in the process $\pi p \rightarrow A_2 p$ is studied and a phase-shift model incorporating a dipole A_2 which produces different peaked structures in the various decay models is given by way of example. (auth)

36942 DISPERSION SUM RULES, INTERFERENCE MODEL, DUALITY, AND THE p-n MASS DIFFERENCE. Hsu, J. P.; Mohapatra, R. N.; Okubo, S. (Univ. of Rochester, N. Y.). Phys. Rev., 181: 2011-17(May 25, 1969).

On the basis of new dispersion relations, an attempt was made to derive an interference model together with the duality principle for the $\pi^-p \rightarrow \pi^0n$ reaction. Also, the same technique was applied to the calculation of the p-n mass difference with some success. (auth)

36943 LOW-ENERGY PION–NUCLEON SCATTERING PHASE SHIFTS. Dutta-Roy, Binayak; Lapidus, I. Richard; Tausner, Menasha J. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 181: 2091-5(May 25, 1969).

Low-energy pion-nucleon scattering phase shifts were calculated using a model which includes only N, N*, ρ, and ϵ intermediate states. This remarkably simple model yields good agreement with phase shifts determined from experimental data. There are two adjustable parameters in the model. The even s-wave scattering length fixes one of these, and the other is determined by the ρ-nucleon magnetic moment coupling. The phase shifts are not sensitive to the choice of this coupling. (auth)

36944 SCHMID LOOPS, NUCLEON RESONANCES, AND DYNAMICS ON THE ARGAND DIAGRAM. Lipshutz, Nelson R. (Duke Univ., Durham, N. C.). Phys. Rev., 181: 1972-9(May 25, 1969).

A method of analysis which is sensitive to the detailed dynam-

ical behavior of the phase shifts is applied to the partial-wave projections of the Regge parametrization of the pion-nucleon charge-exchange spin-flip scattering amplitude. The results of the analysis suggest a number of tests of the resonance interpretation of the loops which appear in these partial-wave projections. (auth)

36945 CONSEQUENCES OF $QQ\bar{Q}$ MODEL FOR MESON–BARYON PROCESSES. II. POSITIVE-PARITY MESONS. Choudhury, D. K.; Gupta, V. K. (Univ. of Delhi). Phys. Rev., 181: 2101-10(May 25, 1969).

The consequences of a $QQ\bar{Q}$ model of meson–baryon processes, proposed recently by Mitra, are examined in relation to production of positive-parity mesons in association with both the octet (B) and the decuplet (B*) of baryons. As Mitra showed, the basic amplitudes which represent the processes $PQ \rightarrow TQ$, $PQ \rightarrow AQ$, $PQ \rightarrow SQ$, and $PQ \rightarrow B'Q$ (where P denotes a pseudoscalar meson and T, A, S, and B′ denote $^3P_{2,1,0}$ and $^1P_1$ mesons, respectively) can be classified in terms of two sets: (+) amplitudes, which represent transitions between positive-parity $QQ\bar{Q}$ states, and (–) amplitudes which represent those between negative-parity $QQ\bar{Q}$ states. The analysis of the data for the processes $PB \rightarrow {}^3P_2B$, made in terms of the density matrices, indicates a predominance of the (+) over the (–) amplitudes. A similar analysis for the processes $PB \rightarrow {}^1P_1B^*$, under the assumption of dominance of one type of amplitude over the other, gives widely different answers for the B* and $^1P_1$ density matrices in the forward direction, so that an experimental test, which may not be too difficult, should be able to throw further light on the hypothesis of the dominance of the (+) amplitudes over the (–) amplitudes for positive-parity meson production. A sum rule of the form $\frac{4}{3}(\rho_{3,3} + \sqrt{3}\rho_{3,-1}) = \rho_{1,1} + \rho_{1,-1}$, which has been derived by previous authors in different models for the reaction $PB \rightarrow VB^*$, is found to be valid also for $PB \rightarrow {}^3P_1B^*$. Some cross-section relations for various processes are also presented and compared with experiment. The agreement is fairly good. As to the possible dynamical significance of the results, they indicate the dominance of the $Q\bar{Q}$ force over QQ, but the assumption of spin and unitary-spin independence of the quark forces does not yield any additional results, unlike the negative-parity meson production considered earlier. Finally, the general classification of the amplitudes in terms of (+) and (–) types, now indicates a dominance of the (+) over the (–) amplitudes, which is exactly the opposite of the conclusion for the production of vector and pseudoscalar mesons, but not necessarily in contradiction with the latter, since the $Q\bar{Q}$ structures of the respective states have opposite parities. (auth)

36946 FORM FACTORS, KRONECKER-δ TERMS, AND THE ABSORPTIVE PERIPHERAL MODEL. Williams, P. K. (Florida State Univ., Tallahassee). Phys. Rev., 181: 1963-6 (May 25, 1969).

A prescription (OPE-δ) is introduced which enables one to obtain with little effort approximate results of absorption-model calculations for spin-space density matrix elements of unstable particles produced in high-energy quasi-two-body inelastic reactions. The OPE-δ method does not involve a partial-wave expansion. It consists of dropping those parts of the OPE amplitudes which would otherwise lead to Kronecker-δ contributions to the partial-wave amplitudes. The method is partially justified by studying results of one-pion-exchange-absorption calculations with and without form factors. Explicit calculations are presented for the reaction $\pi^- + p \rightarrow \rho^- + p$ at 3 BeV/c. (auth)

36947 ACCURACY OF THE TOMONAGA INTERMEDIATE-COUPLING APPROXIMATION. Horowitz, Joel (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 181: 2018-22(May 25, 1969).

The Tomonaga intermediate-coupling approximation and a two-wave-function generalization of it are applied to the system consisting of charged scalar mesons interacting with a static-source nucleon. The generalization allows mesons in the nucleon ground state to occupy either of two states in momentum space. Expressions are obtained for the ground-state wave functions and energy, and for the differential cross section for the elastic scattering of positive mesons by protons. The cross section associated with the one-wave-function approximation differs significantly from the two-wave-function cross section. There is good agreement between the one- and two-wave-function results for static properties of the nucleon. (auth)

36948 HARD-MESON CALCULATIONS AND THE ADLER–DASHEN–GELL-MANN–FUBINI SUM RULE. Young, Bing-lin (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 181: 1878-83(May 25, 1969).

Gerstein has recently found an inconsistency in the modification of the Adler–Dashen–Gell-Mann–Fubini (ADGF) sum rule by Barry et al. (BGS). It is shown that this inconsistency, which is a direct consequence of the assumption by BGS concerning the asymptotic behavior of the off-shell hadron scattering amplitudes, can be removed by a different set of assumptions. Thus a consistent form for the ADGF sum rule can be obtained. Under a more restrictive condition, this new form will reduce to that of ADGF. (auth)

36949 SOME PROCESSES WITH FERMION REGGE POLES. Kudryavtsev, V. A.; Levin, E. M.; Shchipakin, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 9: 1274-9 (June 1969). (In Russian).

Some processes with the high-energy asymptotics dominated by a fermion Regge pole are considered. The specific properties (oscillations in the cross section and in the density matrix, etc.) of the elastic and inelastic reactions due to the fermion pole trajectory (as well as with an account of the vacuum cuts) are discussed. (auth)

36950 APPLICATION OF DISPERSION SUM RULES TO ANALYSIS OF πN SCATTERING AT INTERMEDIATE AND HIGH ENERGIES. Aznauryan, I. G.; Solov'ev, L. D.; Solov'yanov, V. L. Yadern. Fiz., 9: 1245-57(June 1969). (In Russian).

Using the dispersion sum rules and with available experimental data the applicability is analyzed of three models (Regge-pole, interference, and resonance) for description of the πN scattering at intermediate energies. The dispersion sum rules together with the phase-shift analysis up to 2 GeV are used to obtain and test the Regge-pole parameters for every amplitude. For the amplitude $B^{(+)}(\nu,t)$ a domain of possible values of the residual functions $B_P(t)$ and $B_{P'}(t)$ is obtained. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 36503, 36871, 36920, and 37291.

36951 (JINR–E2-4455) GLAUBER REPRESENTATION FOR HIGH ENERGY SCATTERING OF THE DIRAC PARTICLES ON SMOOTH POTENTIALS. Kuleshov, S. P.; Matveev, V. A.; Sissakian, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 11p. Dep.

The Glauber representation for the amplitude of the spin-½ particle scattering on smooth potentials at high energies of incident particles is derived. The consideration is given in the framework of two-component description and on the basis of the Dirac equation. (auth)

36952 (JINR–P2-4510) MESON–NUCLEON CASCADE INTERACTIONS WITH EMULSION IN THE ENERGY RANGE 50 TO 80 GeV. Artykov, I. Z.; Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 8p. (In Russian). Dep.

Average characteristics, calculated within the intranuclear cascade model, are presented for inelastic interactions of nucleons and pions with different groups of the photoemulsion nuclei at energies 50 to 80 GeV. In calculating, multiple interactions inside the nucleus were taken into account. (auth)

36953 DOUBLE REGGE ANALYSIS AND THE EXTENDED DOLEN–HORN–SCHMID DUALITY APPLIED TO THE PROCESSES $pp \rightarrow \Delta^{++}\pi^-p$ AND $pp \rightarrow pp\omega$. Hoeyrup, Jens (Univ., of Copenhagen). Nucl. Phys., B11: 428-38(1969).

A simplified double Regge model analysis is applied down to threshold to the processes $pp \rightarrow \Delta^{++}\pi^-p$ and $pp \rightarrow p\omega p$ in order to test the extension of Dolen-Horn-Schmid duality proposed by Chew and Pignotti. This gives rather good agreement with experiment, and further leads to quantitative conclusions concerning relative couplings of different reggeons, and concerning the vertex functions. The meson-exchange coupling is found to be stronger than the Pomeron exchange in multi-Regge diagrams even at the highest accelerator energies available at present. (auth)

36954 CHARGE EXCHANGE REACTIONS AND CHARGE AND MASS DISTRIBUTIONS IN NUCLEI. Kofoed-Hansen, O (CERN, Geneva); Margolis, B. Nucl. Phys., B11: 455-63(1969).

It is shown that measurements of high-energy charge-exchange reactions on nuclei with incident pions or kaons will furnish a sensitive method for obtaining information on a possible difference between charge and mass distributions in nuclei. The interpretation of experimental results when they become available is discussed on the basis of the Glauber or eikonal approximation applied to Saxon-Woods distributions. (auth)

36955 ON THE EXISTENCE OF PEAKS IN THE CROSS SECTIONS OF THE REACTIONS $p + p \rightarrow d + \pi^+$, $\bar{K} + d \rightarrow p + \Lambda$ AND $p + d \rightarrow {}^3He + X$. Patnaik, P. K.; Maharana, J. (Indian

Inst. of Tech., Kanpur). Nuovo Cim., Lett., 2: 105-8(July 21, 1969).

It is pointed out that the peaks in the cross sections for the interactions $p + p \rightarrow d + \pi^+$, $\bar{K} + d \rightarrow p + \Lambda$, and $p + d \rightarrow {}^3He +$ neutral meson are entirely due to the small binding energy of the deuteron. The positrons of the peaks are calculated analytically from Feynman diagrams and nucleon exchange diagrams and are presented for the different final-state particles in the $p + d \rightarrow {}^3He + X$ reaction. It is pointed out that the existence of the peaks in these reactions can also be inferred from the absorption models and with the help of the impulse approximation. (L.B.S.)

36956 THRESHOLD ANOMALIES AS MANIFESTED BY COUPLING CONSTANTS. van der Merwe, P. du T. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., Lett., 2: 113-15(July 21, 1969).

It is suggested that threshold anomalies (cusps) may be manifested by the coupling constants of composite particles located in the proximity of a threshold. It is shown, for the case of the deuteron, that the coupling constant is characterized by the analytic behavior of the scattering amplitude which in the proximity of a threshold is dominated by the cusp, reducing the dependence of the coupling constants on the binding mechanism only to an implicit one through the masses of the particles in question. This leads to a convenient parametrization of the deuteron coupling constant to nucleons in terms of the deuteron binding energy. (L.B.S.)

36957 SLOPE CHANGES FOR $\ln(d\sigma/dt)$ AND COMPUTATION OF BARYON COMPRESSIBILITY. Libby, L. Marshall (Univ. of Colorado, Boulder. RAND Corp., Santa Monica, Calif.). Contract AT(11-1)-1537. Phys. Lett., 29B: 348-51(June 9, 1969).

The coefficient of baryon compressibility, computed from πp, Kp and pp cross sections at energies up to 30 GeV, is evaluated as 2200, 1800 and 2000 MeV respectively. Requirement that the interaction energy have a minimum predicts the well-known breaks in $\ln(d\sigma/dt$ versus t for proton-proton elastic scattering at 90°. (auth)

36958 REPULSIVE CORE AND INTERACTION ENERGY IN PROTON–PROTON SCATTERING. Libby, L. Marshall (Univ. of Colorado, Boulder. RAND Corp., Santa Monica, Calif.). Phys. Lett., 29B: 345-7(June 9, 1969).

Interaction energy between two protons is computed from high energy elastic cross sections at 60 and 90°, using an optical model. The repulsive core becomes important for separation less than ~0.3 fm. Exponential dependence of high energy cross sections is shown to predict repulsive forces at small separation. (auth)

36959 SELF-CONSISTENT MULTIPLE-QUARK-SCATTERING ANALYSIS OF CONSISTENCY RELATIONS AMONG pp, $p\bar{p}$, πp, AND $\pi\pi$ CROSS SECTIONS. Shrauner, E.; Benofy, L.; Cho, D. W. (Washington Univ., St. Louis). Phys. Rev., 181: 1930-9 (May 25, 1969).

The self-consistent multiple-quark-scattering (SCMQS) picture that was previously used to analyze and account for the details of the pp differential cross section at high energy is here extended to a comprehensive analysis of high-energy hadron scattering according to a set of consistency relations among pp, $p\bar{p}$, πp, and $\pi\pi$ scattering cross sections and the form factors of p and π. The consistency relations are a consequence of the SCMQS picture and the composite SU_3-quark model which has been suggested on non-group-theoretical grounds by the results of the SCMQS analysis of pp scattering, which also indicate very small pointlike quarks. The essence of the consistency relations is illustrated with the first-order single-quark-scattering analysis, and then they are analyzed according to the generalized higher-order SCMQS treatment. Results of the higher-order SCMQS analysis of πp scattering indicate that the pion radius and the inverse diffraction width for $\pi\pi$ diffraction are significantly smaller than indicated by the previously reported results of the single-scattering treatment. Here $r_\pi^2 \cong 0.36 \pm 0.12$ F and $\xi_{\pi\pi} \cong 4.8$ $(\text{BeV}/c)^{-2}$ are obtained, respectively, for the pion charge radius and the inverse diffraction width for $\pi\pi$ scattering. The results also indicate that the pion form factor falls off rapidly at high momentum transfer. Multiple-scattering effects and the interferences among them are seen to be very important characteristics of high-energy hadron-scattering phenomena. (auth)

36960 ABSORPTION MODEL OF NEUTRON–PROTON CHARGE-EXCHANGE SCATTERING. Graves-Morris, P. R. (Univ. of Kent, Eng.). Phys. Rev., 181: 1940-2(May 25, 1969).

The absorption model is shown to describe qualitatively the differential cross-section data for np and $\bar{p}p$ charge-exchange scattering at 2.85 GeV, using π^+ exchange with a form factor at each nucleon vertex and elementary ρ exchange. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 37029.

36961 (MATSCIENCE–61) GROUP THEORY AND UNITARY SYMMETRY. Santhanam, T. S. (Institute of Mathematical Sciences, Madras (India)). [1968]. 90p. Dep. $1.00.

The discussion of group theory and unitary symmetry covers elementary particles, the preliminary mathematics, the Lie group representation and Lie algebras, and a review of unitary groups. Also generating functions of classical groups and evaluation of partition functions are discussed. (J.F.P.)

36962 GROUP-THEORETICAL DERIVATION OF THE PION GAUGE CONDITION. Barut, A. O. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim., Lett., 2: 94-6 (July 21, 1969).

The gauge condition $\lim_{k\mu \to 0} S = 0$ for $j = 0$ massless particles is derived in the framework of the Poincare group. The expression for the transformation property of the S-matrix of an arbitrary process of n particles under the Poincare group is generalized for massless particles using additional transformations, namely the dilatations and the special conformal transformations. (L.B.S.)

36963 THEORY OF FINITE GROUPS. Symposium Held in Boston, May 2–4, 1968. Brauer, Richard; Sah, Chih-han. New York, W. A. Benjamin, Inc., 1969. 272p. $12.50. (CONF-680549–(Absts.)).

The discussion of the theory of finite groups covers characterizations of old and new simple groups and representation theory. Other topics also covered are the order of finite Chevally and Steinberg group, properties of groups with BN pairs, the Steinberg character of a finite group with a BN pair, a sufficient condition for p-stability, the centralizer of involution in finite groups and in finite simple groups, F-projectors, locally finite versus finite simple groups, automorphic algebras, and automorphisms of finite groups. (J.F.P.)

36964 EXACT CONSEQUENCES OF BROKEN O(4) SYMMETRY FOR REGGE TRAJECTORIES. II. INTEGER $M \geq 1$. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 181: 2111-16(May 25, 1969).

The complete set of constraints imposed by broken O(4) symmetry on Regge-daughter sequences having integer $M \geq 1$ are obtained. The constraints determine the pth derivative of all the daughter trajectories at zero energy in terms of a finite number of constants. The conspiring daughters of natural and unnatural parity are highly degenerate for large M; in particular, $\alpha_+(k,t) - \alpha_-(k,t) = O(t^M)$. Results are also obtained for daughter residues. (auth)

36965 SYMMETRIES IMPOSED ON TWO-PARTICLE SYSTEMS. I. A SIMPLE MODE. Klink, William H. (Univ. of Iowa, Iowa City). Phys. Rev., 181: 2023-7(May 25, 1969).

The consequences of imposing symmetries on two-particle systems are discussed. Such symmetries are generated by finding groups which contain the direct product of a space-time group and an internal symmetry group, and which have irreducible representation spaces spanning the space of two-particle states. Consequences of the symmetry arise from assuming that the S operator transforms as an irreducible tensor operator under this group, so that relations between reduced matrix elements occurring in a partial-wave analysis are obtained. (auth)

36966 SYMMETRIES IMPOSED ON TWO-PARTICLE SYSTEMS. II. SYMMETRY AND CROSSED-CHANNEL REACTIONS. Klink, William H. (Univ. of Iowa, Iowa City). Phys. Rev., 181: 2027-39(May 25, 1969).

A partial-wave expansion of the scattering amplitude A(s,t,u) is carried out holding the energy variable s fixed for the reaction $1 + 2 \rightarrow 3 + 4$; another partial-wave expansion for the crossed reaction $1 + \bar{3} \rightarrow \bar{2} + 4$ is carried out for fixed s, which is now a momentum-transfer variable. An SU(2,2) two-particle symmetry is then imposed on the resulting reduced matrix elements, so that the reduced matrix elements are related to one another by SU(2,2) Clebsch-Gordan coefficients. (auth)

36967 T-ODD CORRELATION IN DECAYS OF MESONS WITH SPIN. Kopeliovich, V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1284-6(June 1969). (In Russian).

It is shown that T-odd and CP-noninvariant correlation in decays of mesons with spin is maximal if the interaction in the final state is negligibly small, that is the reason for its substantial difference from the charge asymmetry in the same decays and in the decays $\eta^0, K_L^0 \to \pi^+\pi^-\gamma, \eta^0 \to \pi^+\pi^-\pi^0$. (auth)

36968 NONLINEAR REALIZATION OF CHIRAL SYMMETRY. Gedalin, E. V.; Krasnov, Yu. K. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz., 9: 1287-92(June 1969). (In Russian).

A phenomenological Lagrangian of hadron interactions is obtained based on the non-linear realization of the chiral group. It is shown that the whole complex of interactions of the octet of baryons and nonets of pseudoscalar, vector and axial-vector mesons is described using three constants: the ratio D/F and the constants of the vector and pseudovector interactions of pions with nucleons. (auth)

36969 GEOMETRICAL MODEL OF ELEMENTARY PARTICLES. Menskii, M. B. Yadern. Fiz., 9: 1293-1304(June 1969). (In Russian).

A geometrical model of a free quantum particle is constructed. It is assumed that the geometry of space-time is a quantum superposition of classical geometries each of them possessing a non-Euclidian topology. The group of the particle symmetry (including the Poincare group and the 3 + 2 de Sitter group) as well as its physical interpretation can be unambiguously derived from the geometry. Under some assumptions on the connection of the model with the SU(3) symmetry, the spectrum of masses, spins and parities is predicted which is in agreement with the experimental data on hadrons. (auth)

36970 RELATIVISTIC INVARIANT DECOMPOSITON FOR ONE-PARTICLE HELICITY STATE WITH ZERO MASS. Verdiev, I. A. (Inst. of Physics, Baku). Yadern. Fiz., 9: 1310-13 (June 1969). (In Russian).

Using the methods of integral geometry, decomposition over the irreducible unitary representations of the Lorentz group is obtained for a one-particle zero-mass helicity state. The representations are shown to be fixed by the continuous number ρ and the discrete number λ (helicity). An integral representation for the matrix elements of the representation of the Lorentz group is obtained. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 36526.

36971 GROSS CP VIOLATION IN THE STRONG CUBIC INTERMEDIATE VECTOR BOSON MODEL. Marshak, R. E.; Mohapatra, R. N.; Okubo, S.; Subba, Rao J. (Univ. of Rochester, N. Y.). Nucl. Phys., B11: 253-8(1969).

The gross CP (or equivalently, time-reversal) violation effects predicted by the strong cubic IVB model are discussed for weak decays involving induced neutral currents and for the IVB production process. (auth)

36972 DO $\Delta \neq 0$ SEMILEPTONIC REACTIONS REALLY NOT CONSERVE STRANGENESS. Weiner, Richard M. (Univ. of Bucharest). Rev. Roum. Phys., 14: 69-78(1969).

It is shown that at present there are no proofs for the violation of strangeness in $\Delta S \neq 0$ semileptonic weak interactions. The opposite assumption i.e. the hypothesis that S is conserved in these reactions, together with the assumption that there exist strange leptons, leads to the interdiction of neutral currents and to the $\Delta S \neq \Delta Q$ rule. Four different variants for strange leptons are discussed and possible tests of these variants are proposed. (auth)

36973 CP NONINVARIANCE AND ABNORMAL BOSONS. Lai, C. S.; Nakazawa, K.; Sugano, R. (Dalhousie Univ., Halifax, Nova Scotia). Nuovo Cim., Lett., 1: 865-70(June 11, 1969).

A model of CP violation is constructed in which the origin of CP nonconservation is due to the existence of a medium-strong, C-noninvariant interaction only for abnormal bosons. The model is shown to account for CP violation in $K_L \to 2\pi$ decay and in the charge asymmetry of K_{l3} decay. (L.B.S.)

36974 PHENOMENOLOGICAL ANALYSIS OF $K_{3\pi}$ DECAYS. Chen-Cheung, F.-S.; Saxena, A. (St. John's Univ., Jamaica, N. Y.). Nuovo Cim., Lett., 1: 897-903(June 11, 1969).

A phenomenological analysis of $K_{3\pi}$ decays is made using Lee's harmonic functions in order to study the $\Delta I = 1/2$ rule and CP violation from the data of τ, τ', and K_L^0 (± 0) decays. (L.B.S.)

36975 CP VIOLATION AND THE φ_{00} ANGLE. Chela-Flores, J. (London Univ.). Nuovo Cim., Lett., 1: 884-6 (June 11, 1969).

It is argued that the phase angle φ_{00} for $K^0 \to 2\pi^0$ decay is positive and is approximately the same magnitude as φ_+. (L.B.S.)

36976 TESTS OF CP AND CPT INVARIANCE IN THE DECAY $K_L \to l\bar{l}$. Sehgal, L. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 181: 2151(May 25, 1969).

Pais and Treiman have studied the implications of CP and CPT invariance for the decay $K_L \to l\bar{l}$. It is indicated how their results are modified when account is taken of the possibility of real intermediate states in this decay. (auth)

36977 DERIVATION OF THE BARYON SU(6) MASS FORMULA FROM CHIRAL SU(3) x SU(3) CHARGE ALGEBRA. Nelson, C. A. (Univ. of Maryland, College Park). Phys. Rev., 181: 1946-7 (May 25, 1969).

From the equal-time charge commutator $[\dot{V}_K^s A_K^s]_- = 0$ the Gürsey-Radicati SU(6) mass formula for the 56 baryon multiplet is rederived by making the asymptotic SU(3) approximation. The approximation is to assume that the SU(3) vector charge raising and lowering operators V_K still act in broken symmetry as generators in matrix elements in an appropriately chosen infinite-momentum limit. (auth)

Applications (Strong)

Refer also to abstract 36906.

36978 EFFECTIVE-LAGRANGIAN THEORY OF BROKEN CHIRAL $SU_3 \times SU_3$. Macfarlane, A. J. (Univ. of Cambridge, Eng. Tel-Aviv Univ., Israel); Weisz, P. H. Nuovo Cim., Lett., 2: 25-30(July 1, 1969).

The problem of obtaining physical consequences of broken chiral $SU(3) \times SU(3) \equiv K_3$ within the context of effective-Lagrangian theory is discussed. The Lagrangian is written in the form $L = L_0 + L_B$ where L_0 is K_3-invariant and L_B contains terms which break K_3 and SU_3 invariance. Meson-meson and meson-baryon terms of L_B are exhibited and some immediate consequences are indicated. A program of analysis of meson-baryon scattering in the low-energy region is outlined. Remarks are given on some apparent difficulties in the introduction of symmetry breaking into effective-Lagrangian theory. (L.B.S.)

36979 DYNAMICAL MODEL LEADING TO LINEARLY RISING REGGE TRAJECTORIES. Noga, M.; Cronstroem, C. (Univ. of Helsinki). Phys. Lett., 29B: 442-4(June 23, 1969).

Hadron states lying on a Regge trajectory are assigned to a single irreducible representation of the dynamical group $O(3,1) \sim SL(2C)$. The dynamical algebra is completed by a simple mass condition, which in natural way leads to linearly rising Regge trajectories. (auth)

Field Theories

General

36980 GEOMETRODYNAMICS OF NONNULL ELECTROMAGNETIC FIELDS. Misra, R. M.; Mishra, R. S. (Univ. of Gorakhpur, India. Univ. of Allahabad, India). Tensor, 19: 349-57(Sept. 1968).

An independent derivation of the unified form of the Maxwell equations is presented. The proof is based on the introduction of a spinor space at each point in space-time, and use is made of the relations that then exist between spinors and tensors. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 36877, 36890, and 37021.

36981 A SENSITIVE TEST OF QUANTUM ELECTRODYNAMICS. THE 2S-2P ENERGY DIFFERENCE OF MUONIC HYDROGEN. Di Giacomo, A. (CERN, Geneva). Nucl. Phys., B11: 411-27(1969).

The 2S and 2P energy levels of muonic hydrogen are evaluated with an accuracy of the order of the width produced by the 2P-1S decay. It is shown that a measurement of the 2S-2P transition frequencies with this accuracy would give a precise determination of order α and order α^2 electron vacuum polarization effects, thus providing a very good test of quantum electrodynamics. (auth)

36982 RENORMALIZATION OF CERTAIN MODELS WITH PCAC. Symanzik, K. (DESY, Hamburg). Nuovo Cim., Lett., 2: 10-12(July 1, 1969).

The sigma-model has been studied from the point of view of renormalized perturbation theory. A method is presented to renormalize such theories with PCAC. A scalar theory with broken O_2 symmetry is treated. (L.B.S.)

36983 QUANTUM ELECTRODYNAMICS AS LIMIT OF A VECTOR-MESON THEORY. de Calan, C. (CERN, Geneva); Stora, R.; Zimmermann, W. Nuovo Cim., Lett., 1: 877-83 (June 11, 1969).

The renormalization of a vector-meson field coupled to the conserved current of a spinor field is revicwed. The limit of vanishing meson mass is discussed. Finally the asymptotic condition for the electromagnetic field is compared with corresponding relations used by Källen and Stech, Rollnik and Nunnemann. (L.B.S.)

36984 GENERALIZED FUNCTIONS OF TYPE S AND LOCALIZABLE FIELDS. Constantinescu, F. (Univ., Munich). Nuovo Cim., Lett., 1: 849-53(June 11, 1969).

Generalized functions of the type S are considered as boundary values at analytic functions and the connection with infinite series of derivatives of delta-functions is established. General estimates of the essential singularities of the generating indicatrices are given. They are shown to be of particular importance for the strictly localizable and localizable fields. (L.B.S.)

36985 FIELD–CURRENT IDENTITIES IN A GAUGE-INVARIANT FORMULATION OF MASSIVE VECTOR FIELDS. Ghose, P. (Visva-Bharati Univ., Santiniketan, West Bengal). Nuovo Cim., Lett., 2: 97-100(July 21, 1969).

It is shown that local gauge invariance of the Lagrangian L and hence of the equation of motion may be restored through the introduction of auxiliary massive spinless fields $\sigma(x)$, which are closely related to the gauge fields $V_\mu(x)$. It is also shown that equivalent Lagrangian densities, differing essentially by a total four-divergence term only, can be constructed, which imply the proportionality of hadronic vector currents to either spin-1 parts of the gauge fields or to the mixed gauge fields themselves. Some remarks are given on the construction of a model in which the vector currents are identical with massive, gauge-invariant and conserved spin-1 parts of vector gauge fields, but axial-vector currents are identical with the "partially conserved" mixed axial gauge fields. (L.B.S.)

36986 ON THE THEORY OF RELATIVITY. Kar, K. C.; Dutta, C. (Inst. of Theoretical Physics, Calcutta). Indian J. Theor. Phys., 16: No. 1, 1-6(Mar. 1968).

It has been shown by the wave-statistical and the relativistic method that the electron mass "m" is a vector in the direction of time. This vector property of "m" is utilized to give a very simple proof of the formula $m = m_0\beta$ for the relativistic change of mass. It is also shown that there can be only one formula for the relativistic change of mass and that Einstein's conception of longitudinal and transverse mass is wrong. It is pointed out that the introduction of Mincowski co-ordinate $x_4 = ict$ has made the four dimentional space spherical, leading to wrong conclusion that the electric intensities E_x, E_y and E_z are rotations in 14, 24, and 34 planes. This is not possible since rotations in any plane cannot produce a vector in the same plane. Lastly, it is proved that Lorentz's mechanical equation is invariant. The usual objection against invariance on the ground that the left-hand side of the equation is a vector while the right-hand side is a tensor is not tenable since in this theory the electron mass is a vector and so the left-hand side is also a tensor. (auth)

36987 LAMB SHIFT AND TESTING OF QUANTUM ELECTRODYNAMICS. Kraus, J. (Univ., Munich). Nucl. Phys., B11: 588-94(1969).

It is shown that the Lamb shift is no sensitive probe for high energy modifications of Q.E.D. The small discrepancy between theory and the latest experiment also cannot be explained by the coupling of a neutral vector boson to leptons. (auth)

36988 COMMENTS ON WU'S UPPER BOUND AND CONJECTURE FOR THE HOLOMORPHY ENVELOPE OF THE FOUR-POINT FUNCTION. Manoharan, A. C. (Univ. of Wisconsin, Milwaukee). Phys. Rev., 181: 2146-7(May 25, 1969).

Wu's upper bound for the holomorphy envelope of the four-point function in configuration space is compared with another upper bound which partially supplements the former. (auth)

36989 ANOMALIES IN WARD IDENTITIES FOR THREE-POINT FUNCTIONS. Gertsein, Ira S. (Massachusetts Inst. of Tech., Cambridge); Jackiw, Roman. Contract AT(30-1)-2098. Phys. Rev., 181: 1955-63(May 25, 1969).

The Ward identities for three-point functions of vector, axial-vector, scalar, and pseudoscalar densities constructed in a free-quark model are studied. Divergences in the integral representations for the two- and three-point functions have the effect that not all of the formal Ward identities are satisfied in the model. After making full use of the ambiguities inherent in the definition of linearly divergent objects, as well as adding known polynomials to certain of the three-point functions, it is found that only the Ward identities for three axial-vector densities and for one axial-vector and two vector densities remain unsatisfied. Arguments are presented that for n-point functions with $n > 3$, the Ward identities are satisfied. (auth)

36990 EXTENDED MAGNETIC MONOPOLES IN FIELD THEORY. Ross, D. K. (Stanford Univ., Calif.). Contract AF49(638)1389. Phys. Rev., 181: 2053-63(May 25, 1969).

A field theory of electric and magnetic monopoles which are either point or extended particles is constructed, using Mandelstam's path-dependent field quantities specialized to straight-line paths. Restrictions on the paths and form factors which are needed for self-consistency have been given. It is found that the Jacobi identity is satisfied. Schiff's selection principle for quarks, originally derived in ordinary quantum mechanics, follows easily and is thus generalized to field theory. (auth)

36991 POSITION OPERATORS AND PROPER TIME IN RELATIVISTIC QUANTUM MECHANICS. Johnson, Joseph E. (Univ. of South Carolina, Columbia). Phys. Rev., 181: 1755-64 (May 25, 1969).

Covariant four-vector position operators X^μ are proposed, which form a natural operator generalization of the four-position in relativistic classical mechanics. These X^μ are defined by specifying commutation relations of the X^μ with the Poincaré generators P^μ and $M^{\mu\nu}$, and thereby extending the Poincaré algebra to a larger algebra whose representations are subsequently found. The X^μ are shown to be acceptable relativistic position operators within a proper-time dynamical framework. A single Hamiltonian is used for all spins, with a covariant proper-time description. The dynamics is capable of describing the time evolution of states which are not mass eigenstates. An automatic Foldy-Wouthuysen-type diagonalization is achieved for all spin representations, with spin and orbital angular momentum being separately conserved. The connection with the standard theory is made via the specific field equations. In making this connection to the standard theory of half-integral spins, the origin of Zitterbewegung and the nonseparate conservation of spin and angular momentum are clarified. The connection to Maxwell's equations provides an interesting statement of those equations and of gauge invariance. The unphysical representations of negative and imaginary mass and continuous spin are not present in this formalism. Other features are discussed. (auth)

36992 FEYNMAN RULES FOR ANY SPIN. III. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)2098. Phys. Rev., 181: 1893-9(May 25, 1969).

Free fields, which transform according to general irreducible representations of the homogeneous Lorentz group, are constructed for any spin. The most general interactions may be built up from these fields, without explicit derivatives. The propagators for these fields are calculated in terms of previously calculated propagators for $(2j+1)$-component fields and Racah coefficients. A general formula is given which describes the decomposition of these propagators into various "daughter" spin exchanges. (auth)

36993 SIMPLE PRESCRIPTION FOR QUANTIZING FIELDS APPLIED TO INTERACTING SPINS IN AN ELECTROMAGNETIC FIELD AND TO OTHER SYSTEMS. Sparks, M. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev., 181: 1748-54(May 25, 1969).

A simple prescription for quantizing fields is developed and applied to the system of interacting spins in an electromagnetic field. The classical equations of motion are written in the standard form $-i(d/dt)|V\rangle + \mathfrak{R}|V\rangle = 0$, where the state vector $|V\rangle$ has the state variables, such as the generalized coordinates and momenta, as its components, and the time development operator $\mathfrak{R}$ contains derivative, integral, and matrix operators in general. By diagonalizing $\mathfrak{R}$ and replacing the resulting classical variables with operators obeying boson commutation relations, the system is quantized, and the Hamiltonian and Heisenberg equations of motion are automatically cast into the harmonic-oscillator form. Thus the quantization is reduced to the simple problem of diagonalizing a matrix. This avoids the laborious process of finding a Lagrangian density (by trial and error in general), determining the canonical variables, forming the Hamiltonian density, and inventing transformations to creation and annihilation operators. Problems with zero-frequency modes, which can be annoying in the standard treatment, are auto-

matically eliminated by the prescription. The bookkeeping of forward and backward waves, different branches of dispersion curves, etc., is simplified. In addition to affording a straightforward and simple method of quantizing fields, the method also gives the necessary and sufficient conditions for a Hamiltonian to be transformable into harmonic-oscillator form, gives a direct relation between the classical equations of motion and the Heisenberg quantum-mechanical equations, and gives a simple method of determining the constants of the motion. (auth)

Gravitation and General Relativity

Refer also to abstracts 35516, 36860, and 36921.

36994 CYLINDRICAL WAVE SOLUTIONS OF FIELD EQUATIONS OF GENERAL RELATIVITY CONTAINING ELECTROMAGNETIC FIELDS. Lal, K. B.; Prasad, H. (Univ. of Gorokhpur, India). Tensor, 20: 45-52(Jan. 1969).

Einstein's gravitational field equations of general relativity containing electromagnetic energy tensor along with Maxwell's electromagnetic field equations were solved in a cylindrically symmetric space-time. When the electromagnetic field tensor F_{ij} is taken as functions of (r-t), the cylindrically symmetric space-time is reduced to a plane symmetric space-time in the sense of Taub. But by using the concept of physical components of tensors, it was shown that even if the electromagnetic field tensor F_{ij} is taken as any functions of (r,t), to within some restrictions, exact cylindrical wave solutions of these field equations exist. (auth)

36995 WAVE SOLUTION OF GENERALISED MAXWELL'S FIELD EQUATIONS IN A SPACE-TIME $V_2 \times V_2$ CORRESPONDING TO THE PRODUCT OF TWO SURFACES. Lal, K. B.; Khare, D. C. (Univ. of Gorakhpur, India). Tensor, 20: 53-9(Jan. 1969).

The generalised Maxwell's equations were considered in a Riemannian four-fold of class two representing the product of two surfaces, and it is found that the electromagnetic field in this space-time is nonnull and nonuniform in general. A necessary and sufficient condition, however, was found out in each case when the field is null and when the field is uniform. It was further shown that the electromagnetic components in a $V_2 \times V_2$ when the field is null correspond to those of Peres space-time. (auth)

36996 ON SPHERICALLY SYMMETRIC SPACE-TIMES. I. N-DUALITY AND N-TRANSITIVITY. Kitamura, Shin-ichi (Fukui Univ., Japan). Tensor, 20: 107-20(Jan. 1969).

The properties of a spherically symmetric space-time with respect to N-duality are studied. It is shown that all spherically symmetric space-times are divided into four classes by means of a spherically symmetric null vector field. N-duality is considered with respect to it. Each of these classes is distinguished from the other in the sense that any two space-times which belong to different classes cannot be N-dual to each other with respect to a spherically symmetric null vector of given type. Also the property that arbitrary two space-times of the same class can be N-dual to each other or cannot be is investigated. When arbitrary two of the same class can be N-dual to each other, the class is called N-transitive. It is proved, for example, that all spherically symmetric space-times of the KS type form an N-transitive class and hence that the Schwarzschild space-time is N-dual to the de Sitter space-time. (J.F.P.)

36997 N-DUAL AND PN-DUAL SPACE-TIMES. Takeno, Hyoitiro; Kitamura, Shin-ichi (Hiroshima Univ. Fukui Univ., Japan). Tensor, 19: 174-8(May 1968).

The concept of N-dual and PN-dual space-times is introduced by generalizing the concept of space-times of the KS-type. This concept is applied to the N, P, and H space-times. N is defined as a space-time admitting a parallel null vector field; P is the space-time first obtained by Peres and later generalized by H. Takeno; H is the space-time obtained and studied by H. Takeno. Physically a P and an H represent plane wave-like and plane-wave fields respectively. The term KS-type was used since the idea was obtained by generalizing the theory introduced in general relativity theory by Kerr and Schild. (J.F.P.)

36998 A SOLUTION OF THE FIELD EQUATIONS REPRESENTING A GRAVITATIONAL FIELD OF MAGNETIC TYPE. Misra, R. M.; Narain, Udit; Mishra, R. S. (Univ. of Gorakhpur, India. Univ. of Allahabad, India). Tensor, 19: 203-6(May 1968).

A solution representing a magnetic-type gravitational field is given. The metric is presented, and some properties of the solution are considered. (J.F.P.)

36999 INVARIANCE PROPERTIES OF SPINOR LAGRANGIANS. I. Wainwright, John (Univ. of Waterloo, Ont. Univ. of South Africa, Pretoria). Tensor, 19: 217-32(May 1968).

The invariance properties of variational principles which arise in general relativity theory and in which the unknown functions (or dependent variables) are the components of certain 2-spinors are investigated. The Lagrangians associated with these variational principles are referred to as 2-spinor Lagrangians. The invariance requirements are stated explicitly, and the transformation properties of the derivatives of the general 2-spinor Lagrangian with respect to its various arguments are investigated. Certain combinations of these derivatives which transform as tensor densities and spinors, referred to as covariant Lagrangian derivatives, are constructed. Sets of identities, which are necessary and sufficient in order that the fundamental integral of the general 2-spinor Lagrangian be invariant with respect to L_2 and arbitrary coordinate transformations are derived using the Rund technique. These identities are written in terms of the covariant Lagrangian derivatives in forms which are suitable for physical application. The results are applied to particular cases. (J.F.P.)

37000 INVARIANCE PROPERTIES OF SPINOR LAGRANGIANS. II. Wainwright, John (Univ. of Waterloo, Ont. Univ. of South Africa, Pretoria). Tensor, 19: 265-74(Sept. 1968).

Previous results on invariance properties of spinor Lagrangians are applied to the theory of the interaction of a matter field with a gravitational field and an electromagnetic field within the framework of the 2-spin-tensor formalism of general relativity. Examples are given of fermion spin-$\frac{1}{2}$ and boson spin-1 fields. (J.F.P.)

37001 ON SOME PROPERTIES OF FOUR AND FIVE DIMENSIONAL RIEMANN AND EINSTEIN SPACES AND THEIR APPLICATION TO THE GENERAL THEORY OF RELATIVITY. Jakubowicz, Antoni (Technical Univ. of Szczecin, Poland). Tensor, 19: 329-36(Sept. 1968).

In the discussion of the properties of four- and five-dimensional Riemann and Einstein spaces and their application to general relativity theory, various theorems relating these properties are given and proven. (J.F.P.)

37002 ACCELERATION OF MATERIAL PARTICLES TO THE SPEED OF LIGHT IN GENERAL RELATIVITY. Salzman, F.; Salzman, G. (Univ. of Massachusetts, Boston). Nuovo Cim., Lett., 1: 859-64(June 11, 1969).

A dynamical approach is used to study the motion of test particles and of light in the Schwarzschild field. It is shown that the Schwarzschild solution manifests the possibility of real particles being accelerated to velocities greater than that of light, and that, because of the strong gravitational field near the Schwarzschild radius, any real test particle falling inwards attains the velocity of light uniquely at the point $r = r_s$. (L.B.S.)

37003 ON ASYMPTOTIC CONDITIONS OF SOLUTIONS OF THE EINSTEIN TYPE FIELD EQUATIONS FOR SPHERICALLY SYMMETRIC DISTRIBUTION OF STATIC FLUID. Yokoyama, Kan-ichi (Hiroshima Univ.). Tensor, 20: 60-2(Jan. 1969).

It is shown that if conditions $\lim 1/a = 1$, $\lim r\nu = 0$, $p(r) > 0$, and $\rho(r) > 0$ (where p and ρ are the pressure and density of the fluid) are satisfied in $ds^2 = g_{ij}dx^i dx^j = e^{\nu(r)}dt^2 - a(r)dr^2 - r^2d\theta - r^2\sin^2\theta\, d\phi^2$, $a(r) > 0$ and $T_1^1 = T_2^2 = T_3^3 = -p$, $T_4^4 = \rho$, $T_j^i = 0$ for $i \neq j$, and if $1/a$ and ν are functions of r of class 2 or higher, there is no solution in $R_{ij} - \frac{1}{2}g_{ij}R = -\eta T_{ij}$ for $\eta > 0$. By this theorem it is seen that in the usual gravitational theory one cannot obtain any short-range field potential which falls off more rapidly than $1/r$ as $r \to \infty$ for any fluid with $p > 0$ and $\rho > 0$ because of the positive gravitational constant. (J.F.P.)

37004 GRAVITATIONAL FIELD OF A CHARGED PARTICLE EMBEDDED IN A HOMOGENEOUS UNIVERSE. Shah, Yashodhara P.; Vaidya, P. C. (Gujarat Univ., Ahmedabad, India). Tensor, 19: 191-4(May 1968).

Two solutions of the Einstein-Maxwell equations are obtained. One of these two solutions describes the gravitational field of a charged particle in an Einstein-de Sitter universe. The other is an immediate generalization of the first solution when the curvature of the 3-space of the homogeneous model is k ($\neq 0$). (auth)

37005 REDUCTION OF UNKNOWNS IN EINSTEIN-MAXWELL FIELD EQUATIONS: THE DEGENERATE CASE $\mu = 0$ (THIRD CLASS). Isaak, S. (Wayne State Univ., Detroit). Tensor, 18: 130-40(1967).

The discussion of the degenerate case in the reduction of unknowns in the Einstein-Maxwell field equations covers eigenelements, the metric tensor and Christoffel symbols, induced connections, reduction of the unknowns, and Cauchy data. (J.F.P.)

37006 INTERPRETATION OF THE GENERAL THEORY OF RELATIVITY. Abdil'din, M. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat., No. 4, 76-82(July-Aug. 1968). (In Russian).

The usual approach to the problem of unified geometrization theories of gravitational and also electromagnetic fields supposes a change of the mathematical apparatus of general relativity theory. In this connection it has not been possible up to now to combine gravitation and electromagnetism satisfactorily. Another means of construction for unified geometrization field theories was proposed in principle. The mathematical apparatus remains unchanged, and on the basis of a physical interpretation of this mathematical apparatus a hypothesis is made, slightly different from the Einstein hypothesis. If according to the Einstein four-dimensional metric tensor the Riemann continuum $g_{\mu\nu}$ describes only a gravitational field, then according to the new hypothesis this tensor describes an electromagnetic field as well. Remarkably, that theory, which was based on such a hypothesis, leads to the prediction of a magnetic field with electrically uncharged rotating masses, the possibility of which Einstein postulated. The known empirical relations of Bleket and Wilson concerning the magnetism of celestial bodies are the mathematical consequences of the developed theory, if one is limited by the solution of the field equations in the linear approach. Also predicted is the existence of an interaction between the electrically neutral mass with the magnetic field and the electromagnetic radiation of electrically uncharged masses. It would be interesting to conduct experiments on the discovery of these effects. (tr-auth)

37007 REDUCTION OF UNKNOWNS IN EINSTEIN-MAXWELL FIELD EQUATIONS: THE DEGENERATE CASE $\mu = 0$. Isaak, S. (Wayne State Univ., Detroit). Tensor, 18: 54-64(1967).

The Einstein-Maxwell equations in the form $R^{\nu}_{\lambda} - (1/2)R\delta^{\nu}_{\lambda} = P^{\nu}_{\lambda}$ and $P^{\nu}_{\lambda} = \mu u_{\lambda} u^{\nu} + F^{\nu}_{\lambda} + p\delta^{\nu}_{\lambda}$ are considered where u^{ν} is the timelike unit velocity vector, μ is the rest mass F^{ν}_{λ} the momentum-energy tensor of $k_{\lambda\mu}$ and p the pressure (not hydrodynamical pressure. The problems discussed are the reduction of the number ten of unknowns $g_{\lambda\mu}$ and to solve these equations for the new unknowns by means of Cauchy data. (J.F.P.)

37008 PROPOSAL FOR MEASURING RELATIVISTIC GRAVITY-INDUCED MATTER CONTRACTIONS. Hakner, Richard. Phys. Rev., 181: 1723-9(May 25, 1969).

A system is proposed for detecting a 10^{-18}-Rad change. A laser beam is introduced between two parallel mirrors, M_1 and M_2, and undergoes multiple reflections as a portion of it is deflected onto four photocells D. A slight change in the M_1-M_2 angle results in a large displacement of the light-flux center at D, which disturbs a current null. Long-term drifts could be held to 10^{-18} rad and short-term fluctuations to 10^{-15} rad rms at 1 cps bandwidth. The system could be used to measure relativistic length changes of rigid bodies to within 0.1%. A procedure is devised to cancel elastic distortions. The bending of light in a gravitational field would not be manifest, and the experiment would indicate whether matter is embedded in space. It would also indicate whether Riemannian geometry applies in the domain of quantum mechanics. Some theory is presented to clarify the meaning of relativistic gravitation measurements. The new angle-measuring technique could be adapted to a gravity detector with the capability of sensing a 10^{-15}% change in g, which may be sufficient to detect gravity waves or a time variation in the gravitation constant. (auth)

Scattering Theory

37009 (BNL-50162) REGGE BEHAVIOR AND MULTIPERIPHERAL PROCESSES. LECTURES PRESENTED AT BROOKHAVEN NATIONAL LABORATORY, JANUARY 1969. I. INTRODUCTION AND GENERAL CONCLUSIONS. II. TECHNICAL DISCUSSION. Low, Francis E. (Brookhaven National Lab., Upton, N. Y.). Jan. 1969. 35p. Dep. CFSTI.

High-energy processes for which a Reggistic description may be given are considered. Regge poles, cuts, multi-Regge exchange, the Amati, Fubini, and Stanghellini technique and the multiperipheral Regge model are discussed. (J.F.P.)

37010 (DESY-69/20) NEW FINITE-ENERGY SUM RULES BASED ON THE MULTIPLE-SCATTERING MODEL FOR REGGE CUTS. Schrempp, F. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). June 1969. 9p. Dep.

New finite-energy sum rules (FESR) are proposed for the single-scattering term in Glauber's multiple-scattering formula. In the presence of the whole set of Regge cuts, arising from multiple scattering, there occur only Regge poles on the high-energy side of these FESR. A new interpretation of duality is given, and other possible applications of the FESR are discussed. (auth)

37011 THE TWO-REGGEON/PARTICLE COUPLING. Drummond, I. T.; Landshoff, P. V.; Zakrzewski, W. J. (Univ. of Cambridge, Eng.). Nucl. Phys., B11: 383-405(1969).

A study is made of the two-Reggeon/particle coupling function defined through a production amplitude, with particular reference to its dependence on the Toller angle ω. When one of the Reggeon spins takes a physical value, the coupling function reduces to a polynomial in cos ω. This is understood in several ways: (a) as resulting from the vanishing of non-sense amplitudes in a partial wave decomposition of the production amplitude; (b) in terms of a Fourier transform of the production amplitude; (c) in the perturbation theory; (d) as an extrapolation of the properties of the three-particle coupling that may be deduced from a set of interaction Lagrangians. When the spin of one of the Reggeons is physical the non-vanishing sense amplitudes become equal to the Reggeon/two-particle coupling amplitudes. This is verified in the perturbation theory model for the case of zero spin. The results of the investigation are used to suggest a method of parametrizing the two-Reggeon/particle coupling function which allows it to be approximated from a knowledge of ordinary Regge residues. A generalization of the analysis to the case of parity change at the central vertex is discussed. The implications for non-sense dips in differential cross sections is pointed out. The method of treating external particles with spin is indicated. (auth)

37012 SCATTERING AMPLITUDES THAT SATISFY A MANDELSTAM REPRESENTATION WITH ONE SUBTRACTION AND UNITARITY. Kupsch, J. (CERN, Geneva). Nucl. Phys., B11: 573-87(1969).

It is proved that there exist functions which satisfy a Mandelstam representation with one subtraction elastic unitarity and the inelastic unitarity bounds Im $f_l(s) \geq |f_l(s)|^2$ for all energies. Solutions with positive and with oscillating double spectral functions are given. (auth)

37013 CROSSING-SYMMETRIC REGGE-BEHAVED AMPLITUDES WITH NONLINEAR TRAJECTORIES. Suzuki, Mahiko (Tokyo Univ.). Phys. Rev. Lett., 23: 205-8(July 28, 1969).

An explicit example of crossing-symmetric Regge-behaved amplitudes is constructed for nonlinear trajectories. The Regge behavior is proved for Re $t \to +\infty$, except on the real axis, as well as for Re $t \to -\infty$. (auth)

37014 GENERAL FORM OF REGGE TRAJECTORY AND RESIDUE FUNCTIONS IN THE SCATTERING OF PARTICLES WITH SPIN. Durand III, Loyal (Univ. of Wisconsin, Madison); Fishbane, Paul M.; Klein, Stanley A.; Simmons, L. M. Jr. Phys. Rev. Lett., 23: 201-5(July 28, 1969).

The most general forms for the trajectory and residue functions for daughter Regge poles are presented which are consistent with analyticity and unitarity. The results hold for arbitrary masses and spins of the external particles, all types of conspiracy, and general, nonparallel trajectories. (auth)

37015 DIAGONAL PADE APPROXIMANTS TO THE SOLUTION OF THE LIPPMAN-SCHWINGER EQUATION. Georgalas, C. G. (Univ., Padua). Nuovo Cim., Lett., 1: 871-6(June 11, 1969).

The iterative solution of the Lippmann-Schwinger equation for the off-shell partial-wave T-matrix element in potential theory is considered, assuming that the potential is such as to give rise to a compact kernel. The iterative solution of this equation is considered and certain mathematical properties of its diagonal Padé approximants are proved. The relation between these Padé approximants and the Jost functions is examined. (L.B.S.)

37016 MEANING OF THE VENEZIANO CONDITION. Caprasse, H. (Univ., Liege). Nuovo Cim., Lett., 2: 101-4(July 21, 1969).

The Veneziano condition, $\alpha(s) + \alpha(t) + \alpha(u) = n$ (where n is a positive integer), is examined in the framework of the Veneziano model and of the Virasoro model. The set of trajectories relevant for the $\pi\pi \to \pi\omega$ reaction is illustrated. It is shown that the Veneziano condition eliminates all resonances generated by the wrong-signature pole of the parent trajectory. (L.B.S.)

37017 ON THE DYNAMICAL EQUATION FOR THE POMERANCHUK POLE. Royzen, I. I. (Lebedev Inst. of Physics, Moscow). Phys. Lett., 29B: 428-30(June 23, 1969).

It is shown that the recently suggested bootstrap multi-Regge equation for the Pomeranchuk pole does not possess a solution with the vacuum pole $\alpha_P(0) = 1$, as well as a similar Bethe-Salpeter equation. (auth)

37018 SMOOTHING VENEZIANO. Martin, A. (CERN, Geneva). Phys. Lett., 29B: 431-2(June 23, 1969).

An averaging procedure is applied to the Veneziano formula. The

resulting amplitude has poles on the second sheet and no more poles in the physical region. Crossing symmetry and positivity are preserved. Ways of enforcing unitarity are discussed. (auth)

37019 TOWARD A UNITARIZATION OF THE VENEZIANO MODEL. Atkinson, D. (Imperial Coll. of Science and Tech., London); Balazs, L. A. P.; Calogero, F.; Di Vecchia, P.; Grillo, A.; Lusignoli, M. Phys. Lett., 29B: 423-5(June 23, 1969).

The N/D method is used to constrain the parameters of the Veneziano model. A more refined procedure, preserving exact crossing, is noted. (auth)

37020 ASYMPTOTIC LOWER BOUND FOR THE SCATTERING-AMPLITUDE PHASE IN THE t-PLANE. Tverdokhlebov, A. N. JETP Lett. (USSR) (Engl. Transl.), 9: 327-30(May 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 537-42(May 5, 1969).

The property, asymptotic for real $s \to \infty$, of the phase of the scattering amplitude A(t,s) that for any single-valued, possibly discontinuous, definition of the argument ϕ (t,s) = arg {A(t,s)} in the t-plane, and for real s, the maximum α (s) = max {ϕ(t,s)} is bounded from below when $|t| < s$ by $a^2(s) \gtrsim \pi\mu^2\sigma_{tot}^2(s)/8\sigma_{el}(s)$, where $\sigma_{tot}(s)$ and $\sigma_{el}(s)$ are respectively the total and elastic scattering cross sections of particles of mass μ is obtained. (J.F.P.)

37021 ASYMPTOTIC AMPLITUDES, ASYMPTOTIC EQUIVALENCE, ASYMPTOTIC RELATIONS. Lomsadze, Yu. M.; Tokar, S. S. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh., 14: 614-19(Apr. 1969). (In Russian).

The advantages of introducing the asymptotic Meyman amplitudes $T_\infty(s)$ instead of the exact scattering amplitudes T(s) when proving the Pomeranchuk theorem, its generalizations and other restrictions on the high-energy behavior of the amplitude are shown. These advantages will become especially essential if for sounding the "elementary length" the necessary energies are above the critical one s_{cr}, such that $e^2\ln(s_{cr}/m^2) \sim 1$. An experiment is proposed by means of which it is possible to test the asymptotic equivalence T(s) and $T_\infty(s)$ used essentially in the technique of asymptotic amplitudes. An experiment is also proposed for testing the asymptotic qualities of the moduli of the n-th asymptotic amplitudes $T_n(s)$ of crossed reactions giving a more precise criterion of validity of the fundamental postulates of the quantum field theory in the very high-energy region. (auth)

37022 IMPACT-PARAMETER REPRESENTATIONS AND THE COORDINATE-SPACE DESCRIPTION OF A SCATTERING AMPLITUDE. Chang, N. P. (City Coll., New York); Raman, K. Phys. Rev., 181: 2048-55(May 25, 1969). (NYO-2262TA-197).

It is shown how impact-parameter representations with a dependence on final c.m. momentum k, angle θ, and impact parameter b given by $J_0(kb \sin\theta)$ follow naturally when a scattering process is described in terms of states localized in the transverse plane in coordinate space, or more generally when it is analyzed in terms of a Fourier transform with respect to the transverse momentum. This is discussed for the nonrelativistic as well as the relativistic scattering amplitude. Two classes of impact-parameter representations are considered here: one in which the impact parameter is a position coordinate, canonically conjugate to the transverse momentum; and another —a fixed-energy representation —which is obtained by reinterpreting the Fourier transform with respect to the transverse momentum, in which the impact parameter is not a position coordinate, except in the limit of infinite energy. It is shown that the first kind of impact-parameter representation follows from the description of a scattering process in terms of transient asymptotic states localized in the transverse coordinate space. The distinctive features of each type of representation are pointed out, and the conditions under which each is valid are discussed. (auth)

37023 ITERATIONS OF REGGE CUTS. Landshoff, P. V.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Phys. Rev., 181: 1989-95(May 25, 1969).

The Sudakov technique is used to calculate contributions corresponding to iterations of two-Reggeon cuts. A form is found which agrees with earlier conjectures and which consistently takes into account the requirements of unitarity. It is shown that the expression obtained can be used as the basis for a reformulated multi-Reggeon bootstrap. It is claimed that this version correctly takes into account known cancellation effects. However, it requires more input information than previous versions. (auth)

37024 VARIOUS APPROXIMATIONS TO THE BETHE–SALPETER AMPLITUDE. Cohen, Harold (Texas A and M Univ., College Station); Pagnamenta, Antonio. Phys. Rev., 181: 2098-2100(May 25, 1969).

Relationships are established between several approximate solutions to the Bethe-Salpeter (BS) equation. In the process, a convenient generating function for the [1,N] Padé series for the BS amplitude is obtained. (auth)

37025 MIRAGE TRAJECTORIES. Chu, Shu-yuan (Univ. of California, Riverside); Tan, Chung-I; Ting, Peter D. Contract AT(11-1)34 P 107A. Phys. Rev., 181: 2079-83(May 25, 1969).

A mirage trajectory is a Regge trajectory which has no physical particle lying on it. Both its possible dynamic origin and its peculiar properties are discussed. In particular, the possibility is considered that the Pomeranchon is a mirage trajectory. This conjecture (1) simplifies the structure of Mandelstam-type cuts, (2) gives a simple physical interpretation of the Harari hypothesis, and (3) indicates a possible explanation for the smallness of the Pomeranchon slope near t = 0, while still allowing the Pomeranchon to be a moving pole. (auth)

37026 ITERATION PRINCIPLE FOR DAUGHTER REGGE TRAJECTORIES. Steele, David; Sullivan, J. D. (Univ. of Illinois, Urbana). Contract NSF GP 8081. Phys. Rev., 181: 1927-9 (May 25, 1969).

An iteration principle is given which is satisfied by boson and fermion daughter trajectories. The principle is used to obtain slope formulas for daughter trajectories. (auth)

37027 MODEL OF THE POMERANCHUK POLE-CUT RELATIONSHIP. Chew, G. F. (Univ. of California, Berkeley); Frazer, W. R. Phys. Rev., 181: 1914-18(May 25, 1969).

Using the multiperipheral integral equation at zero momentum transfer, a model is constructed in which the dynamical interrelation of Regge poles and cuts can be studied. Chief attention is paid to the region near J = 1 in an elastic forward amplitude. A consistent solution is found in which the Pomeranchuk pole appears at $J = 1 - a$, with $a \gtrsim 0.01$, while the Amati-Fubini-Stanghellini (AFS) branch point appears at $J = 1 - 2a$. To a good approximation, the pole residue corresponds to the inelastic part of the total cross section, while the integral over the AFS cut corresponds to the elastic cross section. (auth)

37028 REGGEIZED RESONANCE MODEL FOR ARBITRARY PRODUCTION PROCESSES. Bardakci, K. (Univ. of California, Berkeley); Ruegg, H. Phys. Rev., 181: 1884-9(May 25, 1969).

A Reggeized resonance model for a scalar n-point function is given in the form of an integral. Reggeization and a multiple-factorization theorem is proved. Feynman rules are developed for the parent resonance couplings and compared with the Regge results. An approximation scheme for simplifying the n-point function is suggested, and based on this approximation scheme, a Bethe–Salpeter-type equation is derived for the multiperipheral processes. (auth)

37029 INVARIANT EXPANSIONS ON THE CONE AND UNITARY TRANSFORMATIONS OF AMPLITUDES. Liberman, M. A.; Makarov, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 1314-25(June 1969). (In Russian).

Functions on the cone $k^2 = 0$ are constructed that realize unitary irreducible representations of the Lorentz group ($\Delta' = 0$) and correspond to reductions upon different subgroups. The obtained functions are used for invariant expansion of the scattering amplitude and derivation of the relation between the particle and antiparticle scattering amplitudes (the Pomeranchuk theorem). The functions constructed on the cone are used to calculate the coefficients of transitions between the basis vectors of the Lorentz group at the different contractions. (auth)

37030 REAL PART OF THE FORWARD SCATTERING AMPLITUDE AND BACKWARD SCATTERING. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz., 9: 1280-3 (June 1969). (In Russian).

The relation between the ratio of the real part of the forward scattering amplitude to its imaginary part and backward scattering cross section is obtained assuming the existence in the scatterer of a uniform solid core responsible for the large angle scattering. The results are compared with the experiment. (auth)

Particle Accelerators

Refer also to abstracts 35536, 36772, 36817, and 37138.

37031 (AECL–3253) CALCULATION BY CONFORMAL MAPPING OF SHAPES OF POLES OR ELECTRODES FOR QUADRUPOLE LENSES. Lee-Whiting, G. E.; Keech, G. H. (Atomic En-

ergy of Canada Ltd., Chalk River (Ontario)). Feb. 1969. 80p. (FSD/ING-151). Dep. CFSTI. CAN $2.00.

The Schwarz-Christoffel method of conformal transformation is used to derive expressions for the coefficients in the expansion of the field about the axis of a long quadrupole lens. The pole surface is assumed to be equipotential, and the source of the field is assumed to be at infinity. Three polygonal pole shapes and one which is partly curved are treated. In each case the possibility of choosing the parameters so that the fifth- and ninth-order terms in the field expansion vanish is investigated. An attempt is made to make the curved pole as much like a circular arc as possible. (auth)

37032 (BNL-13274(Draft)) PLASMA BETATRON STUDY. Ferrari, Lawrence A.; Zucker, Martin S. (Brookhaven National Lab., Upton, N. Y.). Dec. 1968. 80p. Dep. CFSTI.

After a brief introduction and review of previous plasma betatron experiments, the economic and technological aspects of this type accelerator are discussed. Topics included are particle motion in confined betatron and azimuthal magnetic fields, electrostatic effects, capture into betatron orbits in a plasma betatron, the B_θ turn-on problem, beam loss by gas scattering, synchrotron radiation, obtainable radiation dose, apparatus and preliminary research program, and economics of the plasma betatron and possible future developments. (B.G.D.)

37033 (BNL-50131) THE AGS CONVERSION PROJECT. Brookhaven Lecture Series Number 69. Wheeler, G. W. (Brookhaven National Lab., Upton, N. Y.). Oct. 18, 1967. 15p. Dep. CFSTI.

The AGS conversion project, particularly the objectives, the methods of realizing these objectives, and the progress that has been made in designing and constructing the hardware to achieve them is discussed. The project as described has three main objectives: to increase the accelerated proton beam to 10^{13} protons per pulse, to modify the synchrotron by increasing the cycling rate and duty cycle and by improving its reliability, and to provide additional experimental facilities. (B.G.D.)

37034 (CEAL-1048) OPERATION OF THE CAMBRIDGE ELECTRON ACCELERATOR FOR FISCAL YEARS 1969, 1970, AND 1971. Strauch, K. (Cambridge Electron Accelerator, Mass.). May 1, 1969. Contracts AT(30-1)-2076; AT(30-1)-3025. 44p. Dep. CFSTI.

37035 (EGG-1183-2211) USE OF 50-PICOSECOND LINAC BEAM FOR HIGH-RESOLUTION NEUTRON TIME-OF-FLIGHT MEASUREMENTS. Number S-454-R. Knowlen, R. B.; O'Dell, A. A. (EG and G, Inc., Goleta, Calif.). May 1969. Contract AT(29-1)-1183. 18p. Dep. CFSTI.

The 50-psec high-intensity (14 A, 20.5 MeV) beam from the EG&G/AEC electron linear accelerator was used with subnanosecond timing techniques to make high-resolution (80 psec/m) neutron time-of-flight measurements over a short (25.35 m) flight path. The fast-neutron transmission through a carbon absorber was measured by an NE-102 organic fluor scintillation detector, and the results were used to determine the total neutron cross section for carbon over the energy range of 2.05 to 3.4 MeV. Total cross-section values obtained show good agreement with those determined by others using longer flight paths. Apparatus and techniques used in this experiment are described in detail. (auth)

37036 (EUR-4276) FABRICATION AND TESTING OF DEUTERATED AND TRITIATED POLYPHENYL TARGETS TO BE USED FOR NEUTRON PRODUCTION IN SMALL ACCELERATORS. Final Report. Peters, J. M.; Guillaume, M. A. (Liege Univ. (Belgium). Laboratoire d'Application des Radioelements). Dec. 11, 1968. 40p. (In French). Dep.

As part of a study on tritiated targets destined to produce 14 MeV neutrons, research has been conducted with the aim of exploiting a target of new design, composed of a tritiated high polymer in which the tritium forms an integral part of the molecule. Parapolyphenyl $(C_6H_4)_n$ has great thermal and molecular stability and a high hydrogen content. The method of tritiating this polymer to very high specific activities (31 C/mM) has been perfected and targets made from this compound. The neutron yields of these organic targets were measured under a beam of deuterons with a maximum intensity and energy of 200 μA and 300 keV respectively. (auth)

37037 (EUR-4286(Pt.1)) TRITIATED TITANIUM TARGETS PRODUCING 14-MeV NEUTRONS. PART I. INSTRUMENTATION USED AND TEST CONDITIONS. Final Report. Cuypers, M.; Weber, G.; Guillaume, M. (Liege Univ. (Belgium). Laboratoire des Radioelements). Feb. 20, 1969. 52p. (In French). Dep.

Research studies into the behavior mechanism of tritiated targets producing 14-MeV neutrons require precise knowledge of the conditions for using and testing these targets. A discussion is given of the equipment developed for determining under what conditions these targets can be used. Topics include experimental test conditions, development of pneumatic system, elaboration of a beam scanning device, choice of conditions for measuring neutron yields and evaluation of their thermal component. The results of the experiments, their interpretation, and the conclusions drawn on the optimum working conditions for a classical target are presented. (auth)

37038 (LA-4112) OPERATION OF A RADIO-FREQUENCY NUCLEAR SPIN FILTER. Ohlsen, Gerald G.; McKibben, Joseph L.; Stevens, Ralph R. Jr.; Lawrence, George P.; Lindsay, Ned A. (Los Alamos Scientific Lab., N. Mex.). Feb. 1969. Contract W-7405-eng-36. 12p. Dep. CFSTI.

Details of the construction and operation of the nuclear spin filter in conjunction with the Los Alamos Scientific Laboratory Lamb-shift polarized-ion source are presented. (auth)

37039 (LNF-69/13) MONTE CARLO TYPE PROGRAM FOR THE SIMULATION OF EVENTS PRODUCED IN ADONE IN REGULATING WITH MAGNETIC ANALYZER. Note No. 435. Locci, M. A.; Mencuccini-Spano, M. A.; Nigro, M.; Santangelo, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Mar. 3, 1969. 33p. (In Italian). Dep.

In order to analyze as completely as possible the products of the e^+e^- interactions in Adone, an apparatus was designed consisting of a cylindrical coil inside which an induction field is generated and with a scintillation chamber complex. In order to calculate the detection efficiency for the various reactions, to study the resolution of this apparatus, and to obtain all data useful for the design of an experiment, a Monte Carlo type program was written in FORTRAN IV. The program is given. (J.S.R.)

37040 (NP-17918) COLLECTIVE METHODS OF ACCELERATION. Preprint No. 36. Rabinovich, M. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 44p. (In Russian). Dep.

A general review is given on the aspects of the up-to-date collective methods of acceleration. Basic physical problems on collective methods of acceleration, electron rings, electron currents, plasma accelerators, the magneto-dissipative method of acceleration, the linear plasma betatron, and the radiative method of acceleration are discussed. (R.V.J.)

37041 (NP-17947) ANNUAL REPORT, 1968. (European Organization for Nuclear Research, Geneva (Switzerland)). 196p. Dep.

CERN's activities in 1968 are summarized. Research and development at the 28-GeV proton synchrotron are described including work on beam injection and fast extraction systems, bubble chambers, beam separators and transport systems, data processing systems, and other associated equipment. Progress on construction and development of the Intersecting Storage Rings is presented, and design studies for the 300-GeV proton synchrotron are briefly described. Also the research and development program at the 600-MeV proton synchrocyclotron is discussed. Nuclear and high-energy physics experimental programs are outlined. Administrative data on the finance division, personnel division, and technical services and buildings division are given. (W.H.K.)

37042 (NP-tr-1802) MULTIPLEXED REMOTE CONTROL AND INDICATION FOR BEAM TRANSPORT POWER SUPPLIES. Schneckenburger, P. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Report MPS/PO/Note-68-2. 18p. Dep.

The multiplex system is described for transmission of control signals and indications in connection with beam transport power supplies. The installation consists of the rack ERB 3 or other housing for the rectifiers and the control facilities, including the control room and the beam users. (W.H.K.)

37043 (ORNL-tr-2165) BUILDUP OF LOW-ENERGY RADIATION IN ACCELERATOR SHIELDS. Sychev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P16-4304. 26p. Dep. CFSTI.

The buildup of low-energy radiation in a shield through which high-energy neutrons are propagated is examined on the basis of the theory of the compound nucleus and the evaporation model. By comparing the experimental and calculated results with respect to both the individual components of low energy radiation as well as the total dose, it is concluded that the method discussed is practically acceptable for calculating the shields of accelerators. (auth)

37044 (UCRL-18607) A POLARIZED ION SOURCE FOR THE BERKELEY 88-INCH CYCLOTRON. Luccio, A. U.; Clark,

D. J.; Elo, D.; Frazier, P.; Meiner, H.; Morris, D.; Renkas, M. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 24p. Dep. CFSTI.

A polarized proton and deuteron source for the Berkeley 88-inch cyclotron has been built and presently is being tested. The source, of the atomic beam type, is mounted vertically above the cyclotron, its beam being injected axially into the machine through a hole in the upper yoke. The axial injection system is described elsewhere. The source is of rather conventional design. Our main aim has been to use the best features of the most successful sources in operation in various laboratories, making improvements in design as far as possible. This provides a dependable system, flexible enough to leave room for future developments of the various parts. (auth)

37045 (UCRL-18864) BEVATRON OPERATION AND DEVELOPMENT. [Report No.] 59, July-September 1968. Crebbin, Kenneth C.; Frias, Robert (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 17, 1969. Contract W-7405-eng-48. 11p. Dep. CFSTI.

The Bevatron was "on" for experimenters 84% of the scheduled operating time, and a total of 1.9×10^{18} protons was accelerated this quarter. A total of 14 experiments operated; two experiments were completed. A new technique of flattopping the Bevatron magnet was tested and placed in operation. This new technique has provided a desired reduction in cyclic stress on the motor generator sets and has provided flattops of up to 1 second duration at 5.3 GeV and 2.5 seconds at 3.7 GeV. (auth)

37046 (UCRL-TRANS-1395) ACCELERATION OF MULTIPLE CHARGED IONS BY THE COLLECTIVE METHOD. Iovnovich, M. L.; Rubin, N. B.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Berkeley, from report JINR-P9-4257. 11p. Dep. CFSTI.

It is shown that collective methods of acceleration can be used to develop a compact accelerator of multiple-charged ions which will produce adequate intensity and energy for nuclear physics experiments. (B.G.D.)

37047 (UCRL-Trans-1396) BASIC PRINCIPLES OF A HIGH-DUTY-CYCLE ELECTRON-RING ACCELERATOR. Hultschig, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Translated by J. Silberstein for Univ. of California Lawrence Radiation Lab., Berkeley, from report DESY-F-21-68/1. 10p. Dep. CFSTI.

An effort is made to conceive of an electron-ring accelerator than in principle would allow a repetition frequency greater than 10^6 Hz. Here the repetition frequency, as in earlier proposals, is limited by the charging with protons and forming of the ring. If conventional linacs are used to accelerate the injected electrons, and possibly for subsequent acceleration of the rings, they will probably impose an upper limit on the repetition frequency, of the order of several kHz, so that the frequency possible with the electron-ring accelerator discussed can be achieved only with superconducting linacs. (auth)

37048 (UCRL-Trans-1397) SOME PROPERTIES OF RELATIVISTIC PLASMA RINGS. Kegel, Wilhelm H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Translated for Univ. of California Lawrence Radiation Lab., from report IPP-1. 49p. Dep. CFSTI.

In connection with the project of the electron ring accelerator (ERA), plasma rings are considered which consist of electrons with a relativistic mean velocity and fewer ions with a low mean velocity. The purpose of this report is to derive some necessary conditions for such systems to be in equilibrium. From the relativistic Vlasov equation in cylindrical coordinates moment equations are derived. From these it follows that the electrons are restricted to a finite volume, if one assumes that all macroscopic quantities of the ring vanish at infinity. Separate radial and axial virial theorems for ions and electrons are derived from the moment equations. They relate the average pressure with the integrals over the spatial moments of the electric and magnetic forces. These relations show that in general the ion pressure is anisotropic. Approximate expressions are derived for the virial integrals on the assumption of a low aspect ratio r_0/R. In the case of a homogeneous external field one then obtains relations between the average pressure and the line densities (densities integrated over the cross-section) of the electrons and ions. One further obtains an expression, which shows how the major radius R of the ring is increased by the electromagnetic self-interaction of the ring. Finally it is shown that for the case that the external field is not homogeneous, but a mirror field, the pressure of the electrons in the axial direction is increased appreciably. (auth)

37049 POWER CALIBRATION OF THE SEPARATING MAGNET IN THE CYCLOTRON. Kuzmiak, Mikulas; Kult, Karel (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 15: 197-8(June 1969). (In Czech).

A 100° separating magnet has been built for monochromatisation and stabilization of the external ion beam of the U-120 cyclotron. The magnetic field has been held with the accuracy of 5.10^{-5} using a proton resonance apparatus. The highly sensitive field intensity indication in the air gap assures a good reproducibility of beam energy adjustment at intermittent operation of the accelerator. The magnet has been calibrated with the use of an alpha emitter. (auth)

37050 FAST COAXIAL BEAM CUP (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1879).
3 drawings.

A fast coaxial beam monitoring cup for the Oak Ridge Electron Linear Accelerator is described. The cup is capable of stopping the 140-MeV beam and of dissipating 400 W of average beam power to provide enough overall resolution to count the microstructure pulses displayed on a one-shot distributed-deflection oscilloscope. (For details see TID-4100 Suppl. 53). (See also 22: 22489) (F.S.)

37051 DYNAMICS OF HIGH-CURRENT ELECTRON RING BEAMS IN A TIME-VARYING MAGNETIC FIELD WITH AXIAL SYMMETRY. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett., 29A: 344-5(June 2, 1969).

The effect of self fields on the static and dynamic equilibrium of an electron ring beam in a betatron field is calculated, assuming the energy in the self field to be small (but not negligible) compared with the kinetic energy. (auth)

37052 CERAMIC VACUUM CHAMBERS FOR THE ELECTRON SYNCHROTRON AT DESY, HAMBURG. Gibbons, W. F. (Ferranti Ltd., Manchester, Eng.). pp 255-8 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

The basic requirements for vacuum chambers to be used with the orbit control magnets of an electron synchrotron are detailed. The causes of failure of the epoxy-resin chambers first employed are summarized, the problems to be overcome in making ceramic chambers are considered. Some details of the design and manufacture of the ceramic chambers required for the DESY synchrotron, Hamburg, are discussed, and an account is given of the vacuum aspects of testing, final processing and performance. (auth)

37053 COMPUTER CONTROL OF THE ANALYZING MAGNET OF AN MP TANDEM VAN DE GRAAFF ACCELERATOR. Bergman, Clark; Hobbie, Russell K. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1265. Rev. Sci. Instrum., 40: 1079-81(Aug. 1969). (COO-1265-74).

Tandem Van de Graaff accelerators are often used to measure excitation functions, requiring that the beam energy be repeatedly changed by small amounts. These experiments can be performed with improved efficiency and accuracy by having the on-line computer which controls the experiment set the magnetic field which defines the beam energy. The system used at the University of Minnesota is described. (auth)

37054 VACUUM SYSTEMS OF NUCLEAR-FUSION INSTALLATIONS. Pustovoit, Yu. M. (Inst. of Atomic Energy, Moscow). pp 245-50 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

The vacuum systems of nuclear-fusion installations are considered and compared with the special vacuum systems of particle accelerators and storage rings. Current experiments on controlled fusion reactions and on high-temperature plasma physics make entirely new demands on the design of vacuum systems. In spite of the success of techniques for containing plasma by magnetic fields, the interaction of hot plasma with the walls is becoming the most important factor determining the loss of plasma. Methods of obtaining ultra-high vacua, and the requirements for clean surfaces for maintaining low pressures in the vicinity of a dense plasma, are considered. These problems are compared with those encountered in the design of particle accelerators and storage rings. (auth)

37055 MEASUREMENT OF OMNITRON CRYOPUMPING AND OUTGASSING BY 10^{-16}-TORR PULSE-COUNTING MASS FILTER. Milleron, N.; Wolgast, R.; Nitschke, J. M. (Univ. of California, Berkeley). pp 419-24 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

The Omnitron is a new type of synchrotron accelerator with a storage ring that will deliver beams of light and/or heavy ions to different experiments almost simultaneously. Storage of heavy ions in a high charge state for 20 ms requires that the vacuum environment be assessed more carefully than can be done by the "sum of the partial pressures" convention. A crude figure of merit, $10^{14} \leq N\Sigma n_i Z_i^2$ is used, where $N = 3 \times 10^7$ turns around the accelerator, and n_i = the concentration of atoms of the ith atomic number Z_i. To ensure that this figure of merit is met, outgassing from materials and pumps and pumping speeds are assessed by counting ions from a quadrupole mass filter that can indicate average concentrations of light gas to $<10^{-16}$ torr and $<10^{-15}$ torr of ions with m/e up to 500. Using this, together with an accumulation method, contamination coming from oil D. P. and M. P. systems having special LN traps and valves is shown to be negligible. For the 7-in. D. P. system, no m/e >44 could be detected at an average sensitivity of 10^5 molecules s^{-1}. An average of 10^6 molecules s^{-1} with m/e >44 was detected coming from the M. P. system. A 304-type stainless-steel tube, 3 in. diam. × 0.065 in. wall thickness × 17 in. length, cleaned by a chemical process, was pumped down to the Omnitron figure of merit in <5 h (without bake-out or cooling), using 4°K cryopumping and the clean D. P. system. (auth)

37056 ULTRA-HIGH VACUUM SYSTEM FOR A 3-GeV ELECTRON–POSITRON STORAGE RING AT DESY, HAMBURG. **Pingel, H. (Deutsches Elektronen-Synchrotron, Hamburg).** pp 251-4 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

As an extension to experiments with high-energy nuclear particles, a 3-GeV, 2 × 1 A electron-positron storage ring is planned at DESY, the 6-GeV (7.5 GeV) German electron accelerator. The overall length of the proposed bakeable stainless-steel u.h.v. system for the double ring structure will be 2 × 302.4 m. The average working pressure with full beam current must be within the 10^{-9} torr range, with an outgassing rate of up to 1.5×10^{-4} torr l. s^{-1} for mass 28 in the pre-baked system, produced by synchrotron radiation. A distributed pumping system of about 120 sputter-ion pumps with 5×10^4 l. s^{-1} pumping speed at 6×10^{-9} torr will be able to maintain this required working pressure. During bake-out the system will be pumped down by means of 40 turbomolecular pumps (Pfeiffer type), which may also serve as spare pumps. (auth)

37057 VACUUM PROBLEMS OF THE INTERSECTING STORAGE RINGS AT CERN. **Calder, R. S.; Samuel, R. L. (CERN, Geneva).** pp 259-63 of Proceedings of the Fourth International Vacuum Congress, Manchester, England, April 1968. London, Institute of Physics and Physical Society, 1969.
See CONF-680401.

The intersecting storage rings under construction at CERN present many problems to the vacuum engineer. The system is designed to operate at an average overall pressure of 1×10^{-9} torr (and even at 1×10^{-10}–1×10^{-11} torr at the interaction regions). This condition applies to an ultra-high-vacuum chamber of cross section averaging 160 mm diameter and of approximately 2 km developed length. The size and complexity of the system call for a high degree of reliability in all components. Pumping will be achieved by means of 64 turbomolecular stations (10^{-5} torr), 248 sputter-ion pumps to maintain the average pressure of 10^{-9} torr assisted at critical places by 68 sublimation pumps and, initially, 8 liquid-helium cryopumps to maintain a pressure of 10^{-11} torr at interaction regions. The tubular components of the vacuum chamber will be made from a low-magnetic-permeability (<1.005), high-strength austenitic stainless steel specially treated to maintain a low outgassing rate. The fabrication will require more than 5 km of high-quality TIG welds. More than 5000 all-metal bakeable flange pairs will be used, as well as over 1200 flexible metal bellows, some 40 bakeable sector valves, a large number of roughing valves and several thousand metal/ceramic feed-throughs. More than 500 gauges will be required. An extensive programme of leak detection at all stages of fabrication and assembly is planned. Provision must also be made for the installation of a permanent bake-out system capable of maintaining, if desired, a temperature of 300°C. (auth)

37058 CALCULATION OF THE RESIDUAL PHOTON DOSE RATE AROUND HIGH-ENERGY PROTON ACCELERATORS. **Armstrong, T. W.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.).** Trans. Amer. Nucl. Soc., 12: 391 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37059 USE OF MAGNETS WITH VERTICAL SYMMETRY PLANES IN RING ACCELERATORS. **Melekhin, V. N.** JETP Lett. (USSR) (Engl. Transl.), 9: 337-9(May 5, 1969).
Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 552-6(May 5, 1969).

Features of a system of magnets that focusses particles in mutually perpendicular directions inclined 45° to the radial and vertical directions are described. This motion is realized when magnets with a vertical symmetry plane are used. A system consisting of such alternating magnets without gaps between them are considered. It is found that the closed trajectory of a non-equilibrium particle is shifted radially by a constant amount equal to the average radial shift in the ordinary system and oscillates in a vertical direction. These oscillations give rise to a second-order force containing the nonequilibrium particles. (J.F.P.)

37060 MECHANICAL CONSTRUCTION AND PERFORMANCE OF 6-MeV MEDICAL LINEAR ACCELERATOR. **Tatsuno, Ikuro; Izumi, Naganari (National Kanazawa Hospital, Japan).** Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1510-20(Feb. 1969). (In Japanese).

The construction and performance of the 6 MeV medical linear accelerator installed in the National Kanazawa Hospital are described, and clinical data obtained with the equipment are presented. This machine is the serial No. 2 machine manufactured by Mitsubishi Heavy Industries, LTD. The effective energy for the x-ray which is deduced from a measurement of half value layer with iron was 1.8 MeV. The maximum x-ray output with flattened field was 460 R/min at 1 m from the target. X-ray dose rate was stabilized to less than ±1.5% in fixation and less than ±3% in rotation radiotherapy. The x-ray dose distribution 10 cm below a water phantom was ±2.1%. Excellent isodose curves with various fields from 30 × 30 cm to 2 × 2 cm were obtained. Isodose curves with wedge filter and with lead blocks for field trimming were also made. The focus size of the x-ray target was estimated to be about 1 mm diameter using the pinhole and wire penetrameter radiography. Nominal energy of the electron beam is 6 MeV but actual maximum energy was 6.7 MeV. At 21 pulses per second, the output of the electron beam using 0.6 mm Al scatterer was 1150 R/min on the axis of irradiation at 1 m. Penumbra was reduced to almost nothing but setting the inner jaw of collimator parallel to the electron acceleration axis and the light field corresponded to the actual field. The variance of isocenter in rotation therapy was less than ±0.5 mm. The speed and angle of rotation showed stabilized performance. The leakage dose of x-ray was below permissible level. Tumor air ratio (TAR) was calculated for several field sizes and depths which is very convenient and useful for calculating the air dose. (auth) (NSA of Japan)

37061 SIMPLE-BEAM INDICATOR FOR THE INVESTIGATION OF ION BEAMS. **Kiralyhidi, Laszlo; Kostka, Pal. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 17: 129-33(1969).** (In Hungarian).

A device of simple design is described which was developed to study the parameters of ion beams in the Accelerator Laboratory of the Central Research Institute for Physics. It permits one to check the focusing of the ion beam in an accelerator and proves to be very useful for the investigation of ion sources on a test-stand, e.g., for the evaluation of the emittance diagram. (auth)

37062 CHARGED PARTICLES TRAJECTORY AND POTENTIAL DISTRIBUTION IN A FLAT DISK TYPE ACCELERATION TUBE AND EINZEL LENS. 2. **Takagi, Takashi; Mizuno, Kenichi (Mitsubishi Electric Corp., Amagasaki, Japan).** Mitsubishi Denki Giho, 43: 715-19(May 1969). (In Japanese).

In an electro-static accelerator, especially in a Van de Graaff accelerator, the multistage acceleration tube is estensively used. To elucidate lens action in the region of injection in the acceleration tube, the potential distribution and particle trajectory was calculated in that region. The lens action of an Einzel lens is analyzed to obtain data for general purposes such as focal distances. (auth) (NSA of Japan)

37063 PRESENT STATUS OF ACCELERATOR PHYSICS. **Divatia, A. S. (Bhabha Atomic Research Centre, Trombay, India).** Proc. Nucl. Phys. Solid State Phys. Symp., 1968, Bombay, 67-86(1968).
From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.1).

New concepts as well as technological advances have made it possible to design and build more versatile and bigger particle accelerators during the last decade. Some important concepts are, strong focussing, intersecting beams, storage rings and stochastic acceleration. The characteristics of azimuthally varying field

(AVF) medium energy cyclotrons, and high energy accelerators indicate the advances made due to these concepts. New high energy accelerators, meson factories, and the ommitron, which are being designed, convey a picture of future research trends. A more recent concept being explored is the use of superconducting magnets in accelerators. The most interesting possibilities are indicated by the latest idea of coherent field acceleration, leading to the construction of the electron ring accelerator (ERA). (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 35536, 36694, 36756, 36767, 36796, 36797, 36801, 37191, 37461, 37698, 37699, 37705, 37706, 37722, 37723, 37730, 37747, 37755–37758, 37760, and 37765–37768.

37064 (GA-9326) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period January 1, 1969–March 31, 1969. Slaggie, E. L.; Borgonovi, G. M.; Houston, D. H. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 17, 1969. Contract AT(04-3)-167. 32p. Dep. CFSTI.

Previous measurements of the single differential cross section for neutron scattering by a Be single crystal have now been analyzed. The cross section was put on an absolute basis by using as a reference the scattering from a small disc of polyethylene having about the size of Be single crystal. The results are graphed. The coherent scattering low $S(\alpha,\beta)$ for polycrystalline Be was calculated for $\beta = 0.5$, 1, 1.5, and 2, and the results are plotted. The thermal expansion and phonon frequency shifts in an arbitrary crystal lattice are investigated theoretically. The code QSCAT was used to calculate the coherent elastic neutron scattering by UC and UO_2. (L.T.W.)

37065 (KURRI-TR-10, pp 35-51) MEASUREMENT OF CROSS SECTIONS FOR LOW ENERGY NEUTRONS BY THE TIME-OF-FLIGHT METHOD. Sarada, Toyojiro (Japan Atomic Energy Research Inst., Tokyo). (In Japanese).

Some of the problems associated with slow neutron spectroscopy such as the measurement of total cross sections by the transmission method are discussed. A suitable pulsed neutron source is the chief experimental requirement for this type of spectroscopy. The pulsed neutron beam must have the required energy spectrum, an appropriate neutron pulse (or burst) width, good neutron-pulse repetition rate, a suitable effective area, adequate collimation, and sufficient range. The gamma flash makes neutron detection difficult; methods for counteracting this effect are mentioned, reviewing also methods of monitoring beam intensity and background and the detector types. The measurements included total and partial cross section measurements. The total cross section measurements yield data with good, moderate, and poor resolution. The methods used to analyze these data are discussed. (TTT)

37066 (KURRI-TR-26) NEUTRON PROPAGATION EXPERIMENTS WITH MATERIALS POSSESSING BRAGG CUTOFF. Utsuro, Masahiko; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). Dec. 10, 1966. 14p. (In Japanese). Dep.

The cross section values of graphite for neutrons before and after the Bragg cutoff (neutron energy of about 0.0015 eV) differ by a factor of about 10: the cross section at ordinary temperature is about 4.8 barns for 0.025-eV neutrons; it is but 0.7 barn for 0.001-eV neutrons. As a result, the mean free path of these cold neutrons is nearly 10 cm, and they are able to penetrate graphite to depths of several tens of centimeters without being scattered. The two-group theory was applied to explain this behavior of neutrons with materials possessing Bragg cutoff. The results show that it is necessary to consider neutron groups capable of undergoing two different types of behavior. Neutron propagation experiments must be set up to derive meaningful constants for absorbing media with Bragg cutoff. (TTT)

37067 (RT/FI-(68)52) EUROPIUM AS RESONANT ABSORBER FOR THE SIMULATION OF Pu AND AS SPECTRAL DETECTOR. Orestano, F.; Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 71p. (In Italian). Dep.

Differential cross-section sets were evaluated to describe europium in the thermal and epithermal–fast energy range both as a resonance absorber and as a detector. The sets were tested by comparison between calculated and measured reaction rates in the assemblies devised in order to mock-up plutonium by europium. A correlation method was used to evaluate the sensitivity of ^{151}Eu as a spectral index. (auth)

37068 (RT/FI-(69)2) STUDY OF SELF-SHIELDING OF SMALL PARTICLES OF BORON FOR USE AS A BURNABLE POISON IN IRRADIATION PROCESSES. Ferrari, T.; Santandrea, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 19p. (In Italian). Dep.

Neutron absorption measurements in samples containing burnable poisons were performed after several irradiation steps (up to 1.4×10^{20} n/cm^2). The relative absorption values are correlated with calibration measurements; the effective absorption cross section, corrected by the self-shielding factor, is obtained as a function of the irradiation level, according to a formulation which allows a direct comparison with theoretical previsions. (auth)

37069 SEMIGROUP METHOD APPROACH TO NEUTRON TRANSPORT THEORY. Tataru, P. (Babes-Bolyai Univ., Cluj); Lupu, Gh. Kernenergie, 12: 51-3(Feb. 1969).

Boltzmann's equation for neutron transport phenomena is studied in the framework of the semigroup theory. Conditions of existence and uniqueness for solutions of the equation in the class of square integrable functions in a certain Hilbert space are established. (auth)

37070 SOLUTION OF THE BOLTZMANN EQUATION BY MEANS OF THE JACOBI POLYNOMIALS. Broder, D. L.; Sergeev, I. V.; Platovskikh, Yu. A.; Popkov, K. K. Kernenergie, 12: 53-6(Feb. 1969). (In Russian).

The spherical harmonics method for plane geometry is generalized by the use of Jacobi polynomials containing two arbitrary parameters instead of Legendre polynomials. Distribution functions and elastic scattering cross-section are expanded in polynomials which can have different values. These parameters being properly chosen, the space and energy distribution of neutrons at great distances from the source, calculated for low approximations, is considerably better than in the spherical harmonics method. (auth)

37071 MONATOMIC GAS CROSS SECTION EXPANSION COEFFICIENTS. Clendenin, W. W. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 36: 433-4(June 1969).

The Legendre polynomial expansion coefficients of the neutron scattering cross section of a monatomic gas with arbitrary atomic mass and a Maxwell distribution of atomic velocities are given for the $l = 2$ and 3 cases. (J.W.R.)

37072 ON THE MILNE-PROBLEM EXTRAPOLATION DISTANCE. Bond, G. R.; Siewert, C. E. (North Carolina State Univ., Raleigh). Nucl. Sci. Eng., 36: 447(June 1969).

A "bench mark" calculation of the Milne-problem extrapolation distance for the conservative one-speed transport theory model with isotropic scattering was performed. (J.W.R.)

37073 NEUTRON PULSE SOURCE. Hora, Heinrich; Kronast, Benedikt (to Institut fuer Plasmaphysik Gesellschaft mit beschrankter Haftung). U. S. Patent 3,444,377. May 13, 1969. Priority date Aug. 12, 1964, Germany.

A neutron pulse source for producing very short neutron pulses of extremely high initial neutron flux densities is described. A given small volume containing a given density of heavy hydrogen isotopes in specified proportions in a hot plasma is heated with a laser beam pulse of a given amount of energy over a period of time. The nuclear reactions that result provide the desired neutron pulses. (Offic. Gaz.)

37074 RESOLUTION OF A SYSTEM OF INTEGRAL EQUATIONS FOR MONOENERGETIC NEUTRON SCATTERING BY THE METHOD OF SOLUTION KERNELS. III. Draganu, Mircea (Univ., Cluj). Rev. Roum. Math. Pures Appl., 14: 9-21(1969). (In French).

General considerations developed previously are applied to particular problems of monoenergetic neutron transport with linear isotropic and anisotropic scattering. (tr-auth)

37075 POSSIBLE METHOD OF OBTAINING ULTRACOLD NEUTRONS BY REFLECTION FROM MOVING MIRRORS. Antonov, A. V.; Vul, D. E.; Kazarnovskii, M. V. JETP Lett. (USSR) (Engl. Transl), 9: 180-3(Mar. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 307-11(Mar. 5, 1969).

A set-up of moving mirrors is described which is technically feasible for producing ultracold neutrons through reflection. (J.W.R.)

37076 RESONANCE NEUTRON CAPTURE IN A THICK SLAB OF DEPLETED URANIUM. Lahti, Gerald P. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 12: 389-90(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37077 EFFECTS OF CROSS-SECTION MINIMA ON DEEP PENETRATION OF NEUTRONS. Preeg, W. E.; Goldstein, H. (Columbia Univ., New York). Trans. Amer. Nucl. Soc., 12: 390 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37078 EXPERIMENTAL FAST-NEUTRON PULSE PROPAGATION IN IRON. Napolitano, C. M.; Carroll, E. E.; Ohanian, M. J. (Univ. of Florida, Tallahassee). Trans. Amer. Nucl. Soc., 12: 256(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37079 FEW-SPEED MODEL FOR THERMAL MODERATOR MOTION. Canfield, Eugene H. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 12: 156-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37080 TRANSIENT SOLUTIONS OF THE SLOWING DOWN EQUATION. Williamson, T. J. (Naval Postgraduate School, Monterey, Calif.). Trans. Amer. Nucl. Soc., 12: 193-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37081 SLOW NEUTRON SCATTERING FROM WATER VAPOR. Agrawal, Ashok K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 194-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37082 EFFECT OF NEUTRON THERMALIZATION ON CADMIUM CUTOFF ENERGIES. Brown, H. L. (Drexel Inst. of Tech., Philadelphia); Connolly, T. J.; Cohen, L. D.; Stradling, L. J. Trans. Amer. Nucl. Soc., 12: 192-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37083 USE OF TIME MOMENTS IN THE SPACE-TIME SLOWING DOWN PROBLEM. Diamond, D. J. (Brookhaven National Lab., Upton, N. Y.); Yip, S. Trans. Amer. Nucl. Soc., 12: 211 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37084 SPECTRA OF FAST NEUTRONS FROM WATER PULSED WITH 14-MeV NEUTRONS. Stelts, Marion L.; Anderson, John D.; Goldberg, Eugene; Hansen, Luisa F.; Plechaty, Ernest F.; Wong, Calvin (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 12: 218-19(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37085 ENDF/B EFFECTIVE RESONANCE INTEGRALS. Rothenstein, Wolfgang (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 246-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37086 COMPUTERIZED LIBRARY AND EVALUATION SYSTEM FOR INTEGRAL NEUTRON EXPERIMENTS. Hampel, Viktor E.; Howerton, Robert J.; Wade, John A. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 12: 249-50(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37087 APPROXIMATE CALCULATIONS FOR THE DISAPPEARANCE OF DISCRETE DECAY MODES. Normand, E.; McCormick, N. J. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 12: 252-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37088 AN AUTOMATIC FITTING TECHNIQUE FOR OBTAINING NEUTRON CROSS-SECTION RESONANCE PARAMETERS. Simpson, O. D. (Idaho Nuclear Corp., Idaho Falls); Marshall, N. H. Trans. Amer. Nucl. Soc., 12: 282-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37089 PROPERTIES OF GREEN FUNCTION FOR NEUTRON TRANSPORT EQUATION IN CASE OF INFINITE MOVING MEDIUM. Garusov, E. A.; Petrov, Yu. V. At. Energ. (USSR), 26: 294-6(Mar. 1969). (In Russian).

Problems of neutron transport from a monochromatic monodirected point pulsed source in an infinitely absorbing and scattering homogeneous medium were investigated. The Green's functions were developed as functions of the properties of the medium (e.g., in a gas model they would be a function of the velocity distribution of nuclei in the center-of-mass system) and also of the rate of motion of the medium. (R.V.J.)

37090 ^{238}Pu + Be NEUTRON SOURCES. Kozlov, A. G.; Moiseenko, B. A.; Pavlovich, V. B.; Ponomarev, E. G.; Tyufyakov, N. D.; Shtan, A. S.; Yaskevich, V. S. At. Energ. (USSR), 25: 534-5(Dec. 1968). (In Russian).

Four experimental sources with ^{238}Pu were constructed and the energy spectra recorded by a single-crystal spectrometer with stilbene crystal (d = 30 mm, h = 30 mm) and by a 512-channel amplitude analyzer. The results of studies and measurements of the new ^{238}Pu(α,n) source with the yield of 2.3×10^8 neutr/sec (15 mm in diameter and 48 mm high) confirmed the advantages of using ^{238}Pu for neutron sources with 10^8 to 10^9 neutr/sec yield. (R.V.J.)

37091 PULSED NEUTRON RESEARCH. 2. Yamamuro, Nobuhiro (Tokyo Inst. of Tech.); Shiba, Kiminori. Tokyo Kogyo Daigaku Gakuho, No. 83, 123-30(Mar. 1968).

The neutron thermalization parameters in light water were measured with the help of Friedman's methods. As a new idea, neutron population in the system was counted by means of detection of neutron capture γ rays from the hydrogen nucleus. Using a NaI scintillation counter in the center of water of about 70 cm^3, the same decay constant as the value for an infinite system was observed. The agreement between the experimental and calculated values of the effective absorption cross section was very good, but the experimental absorption cooling (or heating) coefficients did not agree with the calculated one. Also, the neutron slowing down time in graphite was measured, using a NaI scintillator, by means of capture γ-ray detection. A good agreement between the experimental values and the curve calculated by the crystal model (Parks model) was obtained. On the other hand, the pulsed-neutron technique was applied to an enriched uranium and light water subcritical assembly to determine the reactivity by the modified Garelis–Russel method, in which the spectral difference between the prompt and the delayed neutron fluxes was considered. Finally, the prompt neutron decay constants in an unreflected multiplying system were measured as a function of the buckling. It was concluded that the deviation of the spectrum of the finite system from that of the infinite one can be approximately expanded by the power series of buckling. (auth)

37092 INFINITE MEDIUM NEUTRON WAVE PROPAGATION. II. NUMERICAL RESULTS FOR WATER AND GRAPHITE. Warner, J. H. Jr.; Erdmann, R. C. (Univ. of California, Los Angeles). J. Nucl. Energy, 23: 135-45(Apr. 1969).

Numerical results based upon a Fourier transform approach for solving the infinite medium neutron wave propagation problem are presented for water and graphite. Critical frequencies and the frequency range which continuum modes dominate the flux solutions were calculated and the importance of an adequate treatment of cross section properties is demonstrated. A discussion of the experimental implications of the results is also presented. (auth) (UK)

37093 THERMALIZATION AND DIFFUSION OF NEUTRONS IN POLYPHENYLS. Sefidvash, F.; Grant, P. J. (Imperial Coll. of Science and Tech., London). J. Nucl. Energy, 23: 225-37 (Apr. 1969).

The thermal neutron diffusion length in Dowtherm-A was measured at 20°, 50°, 80°, 110°, 140°, 170°, 200°, and 220°C. By varying the neutron absorption cross section by the addition of an organic boron compound, the neutron diffusion constant and diffusion heating constant were determined at 20°, 80°, 140°, and 200°C. A theoretical model (analogous to the Nelkin model for water) for neutron scattering by protons bound in polyphenyls was developed. The physical model comprises a free translator of mass 78, a hindered rotational oscillator of effective mass 21.3 at an energy of 0.02 eV, and two vibrational oscillators at energies 0.146 and 0.38 eV with equal masses of 2.128. The predictions of this model are in good agreement with the experimental results for Dowtherm-A, with experimental data on the diffusion parameters of diphenyl, and with results of neutron scattering law measurements for Santowax-R. The sensitivity of the predictions of the model to the variation of mode parameters was investigated. (auth) (UK)

37094 THE DEPENDENCE OF NEUTRON WAVE PARAMETERS IN POLYCRYSTALLINE MODERATORS ON THE PHONON FREQUENCY SPECTRUM. Wood, J. (Queen Mary Coll., London). J. Nucl. Energy, 23: 211-23(Apr. 1969).

The Boltzmann transport equation for an oscillating plane source of thermal neutrons buried in a non-multiplying medium is investigated for solutions of the type $\phi(E,\mu)\exp(i\omega t - \rho z)$. The resulting eigenvalue equation for the fundamental complex wave parameter, $\rho_0 = \alpha_0 + i\xi_0$, is considered in the multigroup approximation. A rapidly converging iterative scheme for obtaining the exact transport solution (assuming isotropic scattering) and the diffusion approximation solution (for arbitrary $\Sigma_{tr}(E)$) is described. In the calculation of the inelastic scattering kernel, various phenon spectra are used to represent graphite, beryllium, and beryllium oxide. The variation with frequency of the calculated $\alpha_0^2 - \xi_0^2$ and $2\alpha_0\xi_0$ for

these moderators is demonstrated, and, in the case of graphite, a comparison is made with experimental measurements, which shows good agreement when recent phonon distributions are used in the scattering kernel. (auth) (UK)

37095 INFINITE MEDIUM NEUTRON WAVE PROPAGATION. I. THEORY. Warner, J. H. Jr.; Erdmann, R. C. (Univ. of California, Los Angeles). J. Nucl. Energy, 23: 117-34(Apr. 1969).

Neutron wave propagation in an infinite moderating medium is analyzed by the application of energy-dependent transport theory. Solutions are obtained by Fourier transform methods for several scattering kernel approximations. A general isotropic scattering kernel is considered first and is followed by the consideration of two simple kernels for the analysis of wave propagation in noncrystalline and crystalline moderators. In the noncrystalline approximation the structure in the plane of the Fourier transform variable corresponded to a pair of discrete and a two-dimensional continuum of eigenvalues. For the crystalline approximation a more complicated structure was obtained corresponding to a pair of discrete and a disjoint two-dimensional continuum of eigenvalues. (auth) (UK)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstract 36835.

37096 (AECD/EP-17) RELATIVISTIC TABLES OF NEUTRON ENERGIES FROM T(p,n), D(d,n), T(d,n) AND Li(p,n) REACTIONS. Hussain, Muhtasham; Ullah, M. Enayet (Atomic Energy Centre, Dacca (Pakistan)). Feb. 1969. 84p. Dep.

Relativistic tables of neutron energies have been prepared for T(p,n), D(d,n), T(d,n), and Li(p,n) reactions. They give energies in steps of 10 keV of projectile energy for neutrons emitted at various angles. The tables are limited to a maximum energy of 3 MeV for the bombarding particles. (auth)

37097 NEW CHARGE EXCHANGE REACTIONS FOR PRODUCTION OF POLARIZED POSITIVE HYDROGEN IONS. Brueckmann, H.; Finken, D.; Friedrich, L. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Phys. Lett., 29B: 223-5(May 12, 1969).

From considerations concerning the potential curves of ion systems like $X^- + H^+$, some charge exchange reactions are supposed to be able to produce polarized positive hydrogen ions selectively from metastable H(2S) atoms. Charge exchange reactions with H_2, D_2 and He were investigated and the tensor polarization was measured. For polarized ion beam applications these reactions have the advantage of high cross sections. (auth)

37098 ^{2}H(d,γ)^{4}He REACTION FROM 6 TO 19 MeV. Meyerhof, Walter E.; Feldman, William; Gilbert, Stanley; O'Connell, William (Stanford Univ., Calif.). Nucl. Phys., A131: 489-500(1969).

The ^{2}H(d,γ) cross section was measured at 135° from 6 to 19 MeV deuteron energy. At 10 MeV, the c.m. gamma-ray angular distribution was shown to be consistent with $\sin^2\theta\cos^2\theta$ as expected for E2 radiation. Assuming that this distribution obtains over the entire energy range investigated, the total cross section for the inverse reaction is computed for purposes of comparison with other results. This cross section peaks near 31 MeV excitation energy in ^{4}He with a magnitude of 3.0 ± 0.8 μb. The shape of the cross section is not consistent with a simple 2^+ resonance in ^{4}He but indicates a predominantly direct reaction mechanism. The cross-section moments $\int \sigma E_\gamma^{-n} dE_\gamma$ are compared with quadrupole sum rule estimates for n = +2 to −1. (auth)

37099 THE MINIMUM PERCENT D-STATE FOR THE DEUTERON. Levinger, J. S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Lett., 29B: 216-17(May 12, 1969).

The minimum percent D-state for the deuteron is calculated as 0.45%, assuming that the S-wave u(r) is taken from effective range theory, and the D-wave w(r) is chosen to minimize P_D, while fitting the quadrupole moment. (auth)

37100 A METHOD FOR CALCULATING THE GROUND-STATE PROPERTIES OF LIGHT CLOSED-SHELL NUCLEI. II. THE ^{4}He NUCLEUS AND THE EFFECTS OF THE CENTER-OF-MASS MOTION. Blank, J. (Charles Univ., Prague). Czech. J. Phys., 19: 748-62(1969).

The ^{4}He ground state is studied by means of the Goldstone perturbation theory. Explicit expressions for the binding energy up to the second order in the t-interaction and for expectation values of single-particle operators (mean square radius, mass and charge distribution) up to the first order are derived. The effects of the center-of-mass motion of the whole nucleus are considered in detail, especially with respect to mass and charge distribution. The numerical results for the charge form factor and distribution confirm the deviation from the Gaussian model measured recently. (auth)

37101 DETERMINATION OF ^{4}He → ^{3}He + n VERTEX FUNCTION ANALYSING THE DATA ON THE REACTION ^{4}He(p,d)^{3}He IN FRAMEWORK OF PERIPHERAL MODEL. Dolinskii, E. I.; Turovtsev, V. V. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 9: 765-70(Apr. 1969). (In Russian).

Experimental data on the differential cross sections of the reaction ^{4}He(p,d)^{3}He at the proton energies of 31, 55, 93, and 155.4 MeV are analyzed by means of the peripheral model of direct nuclear reactions. Comparing the calculated cross sections with the experimental values, the coupling constant for the virtual process ^{4}He → ^{3}He + n is determined. (auth)

37102 TOTAL CROSS SECTION OF THE REACTION ^{4}He(γ,pn)^{2}H. Arkatov, Yu. M.; Bazaeva, A. V.; Vatset, P. I.; Voloschuk, V. I.; Klyucharev, A. P.; Khodyachikh, A. F. (Physicotechnical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.), 7: 278-9(Apr. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 9: 462-4(Apr. 20, 1969).

The total cross section of the reaction ^{4}He(γ,pn)D was measured (with good statistics) using a diffusion chamber operating in a magnetic field of ~15 kOe and a linear electron accelerator with maximum γ energy of 120 MeV. The dependence of the total cross section on γ energy is shown and compared with experimental and theoretical results of other authors. The maximum of the curve is quite broad. The curve reveals two peaks, with maxima at 50 and 75 MeV. The cross sections at the maxima are 0.2 and 0.17 mb. The experimental curve given by Garbunov et al. (Zh. Eksp. Teor. Fiz. 34: 866(1958)) [Soviet Phys.-JETP 7: 600(1958)] is in good agreement with the first peak. None of the theoretical curves describes the experimental structure of the cross section. (L.T.W.)

37103 NEUTRON–DEUTERON SCATTERING NEAR THRESHOLD: ONE-SHELL TWO-BODY APPROACH. Barton, G. (Univ. of Sussex, Brighton, Eng.); Phillips, A. C. Nucl. Phys., A132: 97-109(1969).

The analytic structure of the on-shell S-wave n–d amplitudes below three-body breakup is considered. It is shown that to a reasonable accuracy some of their main features are dominated by single-proton exchange, and can be understood in a two-body approach through the N/D equations. The quartet scattering length is calculated in closed form in terms of the deuteron binding energy and the triplet effective range, without adjustable parameters; 6.3 fm is predicted compared to the measured 6.17 fm. For doublet scattering, a closed formula is deduced for k cotg δ_2 at very low energies, but need one adjustable parameter fitted to the measured scattering length. Because the scattering length is small, k cotg δ_2 must have a pole very close below threshold. In a model with spin 0 nucleons, it is illustrated, in a physically transparent way, how the triton acquires a bound excited state as soon as the nuclear forces are strong enough to bind the deuteron. Finally, the implications as to what can be learned about the nucleon–nucleon potential from three-body n–d calculations in this energy region are examined. (auth)

37104 STUDY OF THE REACTION D(d,n)^{3}He AT 27.5 MeV BY A TIME-OF-FLIGHT METHOD. Chemarin, M.; Feuvrais, L.; Gouanere, M.; Lemaire, Marie-Claude; Vidal, J.-L. (Univ., Lyon). J. Phys. (Paris), 30: 29-34(Jan. 1969). (In French).

The D(d,n)^{3}He reaction was studied at 28 MeV, using a synchrocyclotron, by a time-of-flight method using the natural pulsation of the beam. The energy resolution (3 MeV) is enough to allow the separation between monoenergetic and break-up neutrons. The angular distribution is compared with the stripping theory of Owen and Madansky and gives an interaction radius of 4.5 fermi. The differential cross section at 0° laboratory angle, after detection efficiency calculations, is estimated at 77 ± 20 mb. (auth)

37105 EFFECT OF WOODS-SAXON WAVE FUNCTIONS ON THE CALCULATION OF A = 18, 206, 210 SPECTRA WITH A REALISTIC INTERACTION. Kahana, S.; Lee, H. C.; Scott, C. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 180: 956-66(Apr. 20, 1969).

The spectra of the nuclei ^{18}O, ^{18}F, ^{206}Pb, ^{210}Pb are calculated using realistic forces and a Woods-Saxon form for the shell-model average field. The substitution of Woods-Saxon for harmonic-oscillator single-particle wave functions leads to appreciable upward shifts in the calculated positions for many low-lying levels in the A = 18 nuclei. In particular the T = 0, J = 1^+ and T = 1, J = 0^+ binding energies are decreased by 0.6–1.7 MeV. In the heavier nuclei, one finds significant changes in observed energy levels perhaps only for the ground states. Nevertheless, the in-

troduction of the more realistic single-particle average field in the Pb isotopes and in neighboring nuclei permits one to improve the conceptual basis upon which this field is erected. (auth)

37106 PRECISION DETERMINATION OF THE D–T NEUTRON SEPARATION ENERGY. Prestwich, W. V.; Thomas, G. E. (Argonne National Lab., Ill.). Phys. Rev., 180: 945-7 (Apr. 20, 1969).

The neutron separation energy for the D(n,γ)T reaction was determined by observing the γ-ray transition with a pair spectrometer consisting of a NaI annulus and a Ge(Li) detector. The energy of the transition was determined relative to an appropriate precision standard. The value obtained, 6257.60 ± 0.3 keV, is in good agreement with previous values and represents a significant improvement in precision. (auth)

37107 DIPOLE SUM RULE FOR THREE-PARTICLE NUCLEI WITH THE GAMMEL–BRUECKNER POTENTIAL. Fetisov, V. N.; Koshelkova, E. V. (Lebedev Inst. of Physics, Moscow). Phys. Lett., 29B: 157-8(Apr. 28, 1969).

The integrated E1 photoabsorption cross section was calculated for three-particle nuclei with the Gammel–Brueckner potential. The insensitivity of the theoretical value σ_0 to the form of realistic potentials is discussed. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 37035, 37096, 37136, 37286, 37298, 37311, 37324, and 37343.

37108 (AE–354) NEUTRON PHYSICS LABORATORY ANNUAL PROGRESS REPORT, OCTOBER 1, 1967–SEPTEMBER 30, 1968. Wiedling, T. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Apr. 1969. 32p. Dep.

Short descriptions are given of experiments going on at the Neutron Physics Branch at the Studsvik Nuclear Research Establishment. The main program concerns fast neutron physics at the Van de Graaff Laboratory with strong emphasis on neutron scattering cross section data of elements of interest for reactor calculations. Since the Van de Graaff accelerator is still the one in Sweden giving the highest potential, it has been quite natural to use the machine also for some nuclear physics experiments with charged particles, though in some cases related to the neutron physics program. In connection with the use of the reactors at Studsvik for physics experiments, research programs have been in progress for several years concerning the use of reactor neutrons for production of isotopes for a systematic study of short lived nuclear isomeric states as well as for the study of the gamma emission in the fission process. (auth) (SWEDEN)

37109 (JINR–E1–4492) EXPERIMENTAL STUDY OF MANY-BODY REACTIONS WITH ^{8}Li PRODUCTION IN SLOW NEGATIVE PION CAPTURE BY ^{12}C, ^{14}N, ^{16}O NUCLEI. Agababian, N. M.; Batusov, Yu. A.; Bunyatov, S. A.; Chernev, Ch. M.; Cuer, P.; Massue, J.-P.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 18p. Dep.

Three-, four-, and five-body reactions leading to ^{8}Li production in negative pion capture by carbon, nitrogen, and oxygen nuclei were studied by using photoemulsion chambers. The relative probabilities of various reaction channels were determined. Measurements were made of the energy spectra and angular correlation of secondary particles for the reactions $\pi^- + {}^{12}C \rightarrow {}^{8}Li + {}^{3}H + {}^{1}H + n$, $\pi^- + {}^{14}N \rightarrow {}^{8}Li + {}^{3}He + {}^{3}H + n$, and $\pi^- + {}^{14}N \rightarrow {}^{8}Li + {}^{4}He + {}^{1}H + n$. The experiments show that four-nucleon clusters (^{4}Li) in the ^{12}C nucleus are of importance in the reactions with ^{8}Li production in slow negative pion capture. (auth)

37110 SHELL-MODEL CALCULATION WITH REACTION MATRIX ELEMENTS. Mercier, Roch (Univ. of Pittsburgh); Baranger, Elizabeth Urey; McCarthy, R. J. Nucl. Phys., A130: 322-32(1969).

A simple shell-model calculation of ^{18}F–^{18}O with no core polarization was performed using reaction matrix elements of the Hamada-Johnston potential. The matrix elements were calculated using harmonic oscillator intermediate states and the matrix inversion technique of Köhler and McCarthy. Results are presented for a variety of choices of the intermediate state spectrum, and it is found that the T = 0 levels are sensitive to this; the T = 1 levels fairly insensitive. The results are compared with experiment and with the calculated values of Kuo. The difference between using the usual Brueckner Q and a more accurate shell-model Q is shown to be significant. Results are presented in which energies used in the reaction matrices are consistent with the resultant energy of each level. (auth)

37111 CALCULATION OF THE NEUTRON AND PROTON SPECTRA FROM THICK TARGETS BOMBARDED BY 450-MeV PROTONS AND COMPARISON WITH EXPERIMENT. Alsmiller, R. G. Jr.; Wachter, J. W.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 36: 291-4(June 1969).

Nucleon–meson cascade calculations were carried out for 450-MeV protons incident on a variety of thick targets. The energy spectra of emitted neutrons and protons at specific angles are compared with experimental measurements. (auth)

37112 DIRECT PHOTOREACTIONS ON ^{13}C AND ^{13}N. Aurdal, T. (Univ. of Bergen). Z. Naturforsch., 24a: 461-2(Mar. 1969).

The electric dipole cross sections of the ^{13}C(γ,n) and ^{13}N(γ,p) reactions were calculated in the framework of the direct interaction model. The wavefunctions were expanded in the L–S coupling scheme, and their radial dependence was found by assuming Saxon-Woods potentials. The cross sections at threshold to about 18 MeV have the right shape and magnitude but maxima are shifted slightly to lower energies. (J.W.R.)

37113 ELASTIC AND INELASTIC SCATTERING OF FAST NEUTRONS FROM ^{10}B, ^{11}B, NATURAL Ge, AND ^{93}Nb. Hopkins, John C.; Drake, D. M. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 36: 275-9(June 1969).

The differential elastic- and inelastic-scattering cross sections of ^{10}B, ^{11}B, natural Ge, and ^{93}Nb were measured at incident neutron energies of 7.02 and 7.55 MeV for ^{10}B; 7.55 MeV for ^{11}B; 7.55 MeV for Ge; and 5.95 and 7.47 MeV for ^{93}Nb. The cross sections were measured with a neutron time-of-flight spectrometer relative to the cross section for neutron scattering from hydrogen. (auth)

37114 THE ^{14}N(n,xγ) REACTION FOR 5.8 ≤ E_n ≤ 8.6 MeV. Dickens, J. K.; Perey, F. G. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 36: 280-90(June 1969).

Gamma-ray spectra were obtained for the reactions ^{14}N(n,n′γ)^{14}N, ^{14}N(n,pγ)^{14}C, and ^{14}N(n,αγ)^{11}B for incident mean neutron energies E_n = 5.8, 6.4, 6.8, 7.4, 8.0, and 8.6 MeV. The gamma rays were detected using a coaxial Ge(Li) detector of 30 cm^3 active volume. The detector was placed at 55 and 90° with respect to the incident neutron direction, and was 77 cm from the sample; time-of-flight was used with the gamma-ray detector to discriminate against pulses due to neutrons and background gamma radiation. The sample was 100 g of Be_3N_2 in the form of a right circular cylinder. Data were also obtained using a 75-g Be sample to provide an estimate of the backgound. The incident neutron beam was produced by bombarding a deuterium-filled gas cell with the pulsed deuteron beam of appropriate energy from the ORNL 6-MV Van de Graaff. The resulting neutron beam was monitored using a scintillation counter; a time-of-flight spectrum from this detector was recorded simultaneously with the gamma-ray data. These data have been studied to obtain absolute cross sections for production of gamma rays from ^{14}N for the incident neutron energies quoted above. The cross sections have been compared, where possible, with previously measured values with good agreement. However, there are several important differences with previous data and these are discussed. In particular, summing the partial cross sections yields a value for the total nonelastic cross section that is approximately half of the total nonelastic cross section obtained from the difference between the total cross section and the total elastic cross section. (auth)

37115 ^{19}F(d,α)^{17}O ANGULAR DISTRIBUTIONS AT E_d = 300 TO 650 keV. Mesko, L.; Schlenk, B.; Somogyi, G.; Valek, A. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Phys., A130: 449-55(1969).

Angular distributions of the α_0, α_1, α_2 and α_3 groups from the reaction ^{19}F(d,α)^{17}O were measured at ten different energies in the range E_d = 300 to 650 keV with a plastic track detector and/or a semiconductor detector. The angular distributions which are energy dependent and asymmetrical about 90°, show the characteristic features of the compound nucleus mechanism. The experimental data were analyzed in terms of Legendre polynomials. The absolute cross section values were determined for the α-groups investigated. (auth)

37116 THE REACTIONS ^{6}Li(n,p)^{6}He(0) AND ^{6}Li(n,n′)^{6}Li (3.56). Presser, G.; Bass, R.; Krueger, K. (Univ., Frankfurt am Main). Nucl. Phys., A131: 679-97(1969).

Integral cross sections were measured for the two analogous reactions ^{6}Li(n,p)^{6}He(0) and ^{6}Li(n,n′)^{6}Li(3.56) from the thresholds up to about 7 MeV with an energy resolution between 50 and 200 keV. The excitation functions exhibit an anomaly at E_n = 4.6 MeV, which is interpreted as due to the lowest T = ½ state in the compound nucleus ^{7}Li. The data are well fitted by the assumption of two overlapping resonances of the same spin and parity ($^{3}/_{2}^{-}$). A

two-level resonance analysis yielded the following level parameters: $E_x^{(1)}(^7Li) = 10.25 \pm 0.10$ MeV, $\Gamma^{(1)} = 1.40 \pm 0.10$ MeV, $T^{(1)} = 1/2$; $E_x^{(2)}(^7Li) = 11.20 \pm 0.05$ MeV, $\Gamma^{(2)} = 0.27 \pm 0.05$ MeV, $T^{(2)} = 3/2$. Partial widths and reduced widths of the resonances were derived or estimated, and their implications for the structure and isospin purity of the resonant states are discussed. (auth)

37117 REACTIONS (γ,p), (γ,d), (γ,t) ON NUCLEI ^{7}Li, ^{12}C, AND ^{181}Ta WITH PHOTON ENERGIES 400 TO 1300 MeV. Antuf'ev, Yu. P.; Agranovich, V. L.; Ganenko, V. B.; Kuzmenko, V. S.; Miroshnichenko, I. I.; Sorokin, P. V. (Kharkov Inst. of Low-Temperature Physics and Tech.). Ukr. Fiz. Zh., 14: 499-506 (Mar. 1969). (In Russian).

The differential cross sections of (γ,p), (γ,d), and (γ,t) reactions on carbon for 700- and 1200-MeV maximum energies of photons and energy distributions of the secondary particles were measured at 30, 60, and 120° particle-emission angles. Excitation functions for protons with energy of 97 MeV are given for the maximum incident photon energy from 400 to 1300 MeV. Deuteron to proton and triton to deuteron yield ratios for various nuclei are also shown. Experiment was carried out at the Kharkov linear accelerator. The particles were detected by scintillation counters after a magnetic spectrometer. Possible mechanisms of the high energy photo-nuclei interaction are discussed. (auth)

37118 INVESTIGATION OF (γ,p) REACTION ON THE ^{7}Li NUCLEUS BY MEANS OF A BEAM OF QUASIMONOCHROMATIC AND POLARIZED PHOTONS. Antufev, Yu. P.; Zhebrovskii, Yu. V.; Kolesnikov, L. Ya.; Kuzmenko, V. S.; Miroshnichenko, I. I.; Rubashkin, A. L.; Sorokin, P. V. (Inst. of Physics and Tech., Kiev). Yadern. Fiz., 9: 680-5(Apr. 1969). (In Russian).

The reaction (γ,p) on ^{7}Li was studied with a beam of coherent linearly polarized bremstrahlung radiation resulting from electrons retarding on a diamond monocrystal. The measured sensitivity of the reaction on ^{7}Li to photon polarization qualitatively coincides with that for the pion photoproduction processes on free nucleons. Results obtained show that the proton yield at the nuclear photodesintegration under energies and angles corresponding to kinematics of the pion photoproduction on free nucleons, is mainly due to the mesonic mechanism of photon interaction. (auth)

37119 BREAK-UP OF LITHIUM NUCLEI. Ismatov, E. I. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 46-9(1968). (In Russian).

Break-up of Li nuclei in nuclear reactions was studied with a phenomenological potential containing a Coulomb interaction potential. The angular distributions for ^{6}Li spallation during scattering on ^{12}C at 30 MeV were calculated. The Coulomb spallation cross section reached significant magnitude. Cross sections for Coulomb spallation of ^{6}Li and ^{7}Li during bombardment by 25-MeV α particles were calculated. (R.V.J.)

37120 STRUCTURE OF LOW-LYING STATES IN A = 15 NUCLEI. Alford, W. P.; Purser, K. H. (Univ. of Rochester, N. Y.). Nucl. Phys., A132: 86-96(1969).

States in ^{15}O up to 8.32 MeV excitation were studied in the ^{14}N(^{3}He,d)^{15}O reaction at 14 MeV. States in ^{15}N up to 6.33 MeV excitation were observed in the reaction ^{14}C(^{3}He,d)^{15}N at the same energy. Angular distributions were measured between 10° and 40° lab, and l-values and spectroscopic factors were obtained by comparison with DW calculations. The results were compared with the results of several calculations for A = 14 ground-state wave functions. Spectroscopic factors for transitions to even-parity states in A = 15 nuclei are in excellent agreement with calculations of Halbert and French. (auth)

37121 STRUCTURE IN THE EXCITATION FUNCTIONS OF (^{3}He,α) REACTIONS ON A NUMBER OF ALPHA-TYPE NUCLEI. da Silva, C. M.; Newton, J. O.; Lisle, J. C.; da Silva, M. F. (Univ. of Manchester, Eng.). Nucl. Phys., A132: 9-27(1969).

Excitation functions were measured for the reactions ^{16}O(^{3}He,α)^{15}O and ^{28}Si(^{3}He,α)^{27}Si over a bombarding energy range 4.0 to 9.0 MeV and for the reaction ^{24}Mg(^{3}He,α)^{23}Mg from 4.0 to 6.2 MeV. An analysis of the data using the statistical model of Ericson was attempted, and coherence widths of 130 ± 20 keV for ^{19}Ne, 125 ± 30 keV for ^{27}Si, and 102 ± 10 keV for ^{31}S are found. The reactions appear to proceed predominantly by a direct mechanism. However, the assumptions of the Ericson theory are not fully satisfied, since a wider structure is found in the experimental data. Possible interpretations of this structure are discussed. (auth)

37122 A DIRECT MEASUREMENT OF PARTICLE-HOLE IMPURITIES IN THE GROUND STATE OF ^{16}O. Purser, K. H.; Alford, W. P.; Cline, D.; Fulbright, H. W.; Gove, H. E.; Krick, M. S. (Univ. of Rochester, N. Y.). Nucl. Phys., A132: 75-85 (1969).

The pickup reactions ^{16}O(d,t)^{15}O and ^{16}O(d,^{3}He)^{15}N were investigated at a deuteron energy of 20 MeV to allow a direct measurement of the two-particle–two-hole admixtures in the ground-state wave function of ^{16}O. The results give good evidence for the existence of such pair excitations with intensities comparable to those predicted by Brown and Green. (auth)

37123 EXCITATION CURVE OF ^{12}C(α,n)^{15}O REACTION. Spasskii, A. V.; Teplov, I. B.; Fateeva, L. N. At. Energ. (USSR), 26: 303-4(Mar. 1969). (In Russian).

The excitation curve of the ^{12}C(α,n)^{15}O reaction from 13 to 25 MeV was measured by a stack method in a 120-cm cyclotron. The target, consisting of a stack of lawsonite films ($C_{10}H_8O_4$) 0.7 to 1.3 mg/cm^2 each, was irradiated by α particles. The cross sections of the reaction ^{12}C(α,n)^{15}O, determined by the decay curves obtained for each lawsonite film, are in good agreement with Sternheimer (Phys. Rev., 115: 137(1959)). The excitation curve is nonmonotonous in character, indicating that the reaction proceeds mainly with formation of the compound nucleus. The scheme for the ^{15}O levels was constructed on the basis of the excitation curve for the ^{12}C(α,n)^{15}O reaction, and data on complete cross sections for the reaction ^{12}C(α,p)^{15}N developed by I. B. Teplov et al., (Zh. Eksp. Tekh. Fiz., 48: 385(1965)). The position of the maxima indicated that in both reactions the mechanism of formation of the compound nucleus played an important part. (R.V.J.)

37124 STUDY OF FIRST EXCITED LEVELS OF ^{6}Li. Linck, I.; Bilwes, R.; Kraus, L.; Seltz, R.; Magnac-Valette, D. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 30: 17-28(Jan. 1969). (In French).

A new diagram of the five first excited levels of ^{6}Li is deduced from the spectroscopic study of the ^{7}Li(^{3}He,α)^{6}Li reaction between 1 and 12 MeV laboratory energy and from the S-matrix formalism interpretation of the ^{4}He + d resonant scattering. The angular distributions and excitation curves of α-particles in the first reaction are tentatively interpreted by direct processes in the D.W.B.A. theory. (auth)

37125 ^{11}B(^{3}H,α)^{10}B REACTION AT 33 MeV. Dehnhard, D.; Williams, N.; Yntema, J. L. (Argonne National Lab., Ill.). Phys. Rev., 180: 967-70(Apr. 20, 1969).

Differential cross sections of the ^{11}B(^{3}He,α)^{10}B reaction leading to seven states up to 5.2-MeV excitation energy were measured at forward angles at an incident energy E(^{3}He) = 33 MeV. The angular distributions were analyzed in terms of the distorted-wave Born approximation on the assumption that the direct neutron-pickup process is predominant. Relative spectroscopic factors were extracted and are found to be in good agreement with Cohen and Kurath's theoretical predictions and with the results of the ^{11}B(p,d)^{10}B experiment at 33.6 MeV. (auth)

37126 ELASTIC SCATTERING OF 21-MeV PROTONS FROM ^{14}N, ^{16}O, ^{40}Ar, ^{58}Ni, AND ^{116}Sn. Baron, Norton; Leonard, Regis F. (Lewis Research Center, Cleveland). Contract AT(11-1)-535. Phys. Rev., 180: 978-86(Apr. 20, 1969).

Differential cross sections were measured for 21-MeV incident protons elastically scattered from ^{14}N, ^{16}O, ^{40}Ar, ^{58}Ni, and ^{116}Sn. An optical-model analysis was performed on these data as well as on previously measured elastic polarizations of 21-MeV incident protons scattered from the same nuclei. The optical potential used in this analysis included a real central term, a surface absorption term, and a real spin-orbit term. Good fits to both the cross sections and polarizations for all nuclei except ^{16}O were obtained by allowing the nine parameters of the optical potential to vary from nucleus to nucleus. The diffuseness parameters derived to fit the ^{14}N and ^{16}O data in general differ considerably from those derived to fit the scattering from the heavier nuclei. These results are compared with those of two other calculations in which two different sets of nonunique constant geometrical optical-model parameters were assumed and only the three potential strengths were obtained by searching. As expected, these constant-geometry calculations gave poorer agreement with the data. The disagreement with the polarizations of ^{14}N and ^{16}O was very pronounced. (auth)

37127 SPIN FLIP IN THE INELASTIC SCATTERING OF PROTONS. Kolasinski, W. A.; Eenmaa, J.; Schmidt, F. H.; Sherif, H.; Tesmer, J. R. (Univ. of Washington, Seattle). Phys. Rev., 180: 1006-14(Apr. 20, 1969).

Proton spin-flip probabilities and differential inelastic scattering cross sections were measured over a large angular region for the following 2^+ excitations: 4.44 MeV in ^{12}C at 12, 13, 14, 15, and 20 MeV; 1.45 MeV in ^{58}Ni at 9.25, 10.46, 15, and 20 MeV; 1.33 MeV in ^{60}Ni at 10.5 and 14 MeV; and 1.34 MeV in ^{64}Ni at 10.5 and 14 MeV. The results were analyzed in the distorted-wave Born approximation, with collective-model form factors derived from the optical-model potential. The deformed spin-dependent part of the coupling potential was of the full Thomas form, and the data are best described when $\beta_T^0 > \beta_S$. Good fits are obtained for elastic polarization data (obtained elsewhere) when the depth of the spin-

orbit potential is determined from spin-flip probability measurements. (auth)

37128 DESCRIPTION OF ^{16}O–^{16}O ELASTIC SCATTERING NEAR THE COULOMB BARRIER. Chatwin, R. A.; Eck, J. S.; Richter, A.; Robson, D. (Florida State Univ., Tallahassee). Phys. Rev., 180: 1049-52(Apr. 20, 1969).

The excitation function at 90° in the c.m. system, just above the Coulomb barrier, and an angular distribution at 13-MeV c.m. energy, were analyzed with a conventional complex potential Woods-Saxon shape. The excellent fit obtained led to almost the same parameters that were used to describe $^{16}O-^{16}O$ scattering data at higher energies by Siemssen et al. A real $^{16}O-^{16}O$ interaction with a repulsive core does not fit the excitation function at c.m. energies from 10–14 MeV, contrary to the conclusion of Brueckner et al. When absorption is added, the Coulomb potential masks the nuclear interior, and thus the elastic scattering data cannot be used as sensitive evidence for the existence of a repulsive core. The conclusion of Brueckner et al. seems to be affected by incorrect phase shifts. (auth)

37129 THREE-BODY FORCES AND THE BINDING ENERGY OF LIGHT NUCLEI. Nash, G. F. (Southampton Univ., Eng.). Nuovo Cim., 61B: 261-70(June 11, 1969).

A phenomenological nuclear interaction consisting of a two-body potential containing a Gaussian with exchange and a delta-function, together with a three-body potential of a generalized Gaussian, was fitted to ^{4}He and to the single-particle values of ^{16}O. The binding energies of ^{8}Be, ^{12}C, and ^{16}O were calculated with this potential. The three-body term was found to contribute some five MeV to the binding in ^{16}O. An interaction consisting of a two-body Gaussian with exchange and a three-body Gaussian with exchange was found not to bind ^{16}O. (auth)

37130 RECENT DEVELOPMENTS IN THE DESCRIPTION OF COLLECTIVE MODES IN NUCLEI. Nair, S. C. K. (Saha Inst. of Nuclear Physics, Calcutta). Proc. Nucl. Phys. Solid State Phys. Symp., 1968, Bombay, 11-18(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.1).

The application of the generator coordinate approach to the rotational states of ^{16}O, ^{20}Ne, ^{24}Mg, and ^{28}Si is discussed. (J.W.R.)

37131 EXCITED LEVELS OF ^{10}B OBTAINED BY THE REACTION OF 4-MeV DEUTERONS ON ^{9}Be. Rosier, Louis-Hubert; Deschamps, Yvon; Tamisier, Roland (Laboratoire de Spectroscopie Nucleaire, Nantes, France). Compt. Rend., Ser. B, 268: 1149-52(Apr. 28, 1969). (In French).

The angular distributions of neutrons corresponding to the levels of ^{10}B at 3.59, 4.77, 5.14, 5.93, and 6.16 MeV were analyzed by a stripping mechanism in the DWBA. A good agreement was obtained for the levels with low energy balance (5.14, 5.92, and 6.16 MeV); on the contrary, the levels excited at 3.59 and 4.77 MeV can not be interpreted by pure stripping. (tr-auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 35049, 35253, 35501, 37108, 37111, 37113, 37116, 37121, 37126, 37127, 37130, 37189, 37235, 37286, 37290, 37299, 37327, 37328, 37345, 37350, and 37356.

37132 (AD-679574) RECALCULATION OF NEUTRON OPTICAL MODEL PARAMETERS AND INELASTIC SCATTERING CROSS SECTIONS FOR Na, Mg, Al, Si, S, Ti, Cr, and Fe. Ferguson, James M. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 21, 1968. 18p. (USNRDL-TR-68-116). CFSTI.

A revised set of calculations of secondary gamma-ray production cross sections is presented. The new calculations differ from earlier ones in that they were performed with optical model potentials which were individually fit to elastic scattering data for the appropriate element. Optical model parameters for Na, Mg, Al, Si, S, Ti, Cr, and Fe are presented. Secondary gamma-ray cross sections for Na, Mg, and Al are compared with experiment. The use of individually fit values of the optical model parameters did not clear up all the discrepancies between the mensurements and the calculations. Some possible reasons for the remaining discrepancies are suggested. (auth) (USGRDR)

37133 (AD-679907) NEUTRON AND GAMMA-RAY PRODUCTION CROSS SECTIONS FOR SILICON. Final Report, September 1967–April 1968. Drake, M. K. (Gulf General Atomic, Inc., San Diego, Calif.). May 1, 1968. Contract DASA01-68-C-0036. 209p. (GA-8628; DASA-2099). CFSTI.

A survey was made of the available information on neutron and gamma ray production cross section measurements of silicon. Evaluated nuclear data sets were prepared for silicon that cover the energy range from 0.001 eV to 20.0 MeV. These cross section sets were based on experimental results available to January 1968 and on nuclear model calculations. (auth) (USGRDR)

37134 (AD-681890) MEASUREMENT OF TOTAL NEUTRON CROSS SECTIONS AT THE US ARMY NUCLEAR DEFENSE LABORATORY. Bacon, E. G. Jr.; Quigley, E. F.; Barrows, A. W. Jr.; Van Antwerp, W. R. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Dec. 1968. 19p. (NDL-SP-34). CFSTI.

The transmission method for measuring total neutron cross sections is described. The methods of sample alignment and transmission minimization are discussed. In addition, a review of the theory is given. Results for total neutron cross sections of gadolinium, calcium, and potassium, obtained by the transmission method, are presented. (auth) (USGRDR)

37135 (CONF-681210-(Vol.1)) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, BOMBAY, DECEMBER 28–31, 1968. VOLUME 1. INVITED TALKS. (Department of Atomic Energy, Bombay (India). Physics Committee). 1968. 316p.

Separate abstracts were prepared for 8 of the 14 papers included. The remaining 6 papers are not in the scope of NSA. (J.W.R.)

For abstracts of individual papers see: 36796, 37063, 37130, 37256, and 37352–37355.

37136 (MLM-1644) ENERGY LEVELS OF ^{21}Na. Haas, F. X. Jr. (Mound Lab., Miamisburg, Ohio). May 20, 1969. Contract AT-33-1-GEN-53. 135p. Dep. CFSTI.

The energy levels of ^{21}Na were studied through the $^{19}F(^{3}He,n\gamma)$, $^{20}Ne(p,\gamma)$, and $^{20}Ne(d,p)$ reactions. The n-γ coincidence spectra were measured for the $^{19}F(^{3}He,n\gamma)$ reaction at 2.5-MeV ^{3}He energies. Gamma spectra were measured for the $^{20}Ne(p,\gamma)$ reaction at proton energies of 1 to 2.2 MeV. Differential cross sections were measured for the $^{20}Ne(d,p)$ reaction at deuteron energies of 3.6 to 6 MeV. Spectroscopic factors and branching ratios were determined for transitions in ^{21}Na. (J.W.R.)

37137 (NYO-2897-35) NUCLEAR CHEMISTRY RESEARCH OF HIGH-ENERGY NUCLEAR REACTIONS AT CARNEGIE-MELLON UNIVERSITY. Annual Progress Report, 1968–1969. Caretto, Albert A. Jr. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry). June 1, 1969. Contract AT(30-1)-2897. 193p. Dep. CFSTI.

COPPER-63 — proton reactions (p,n) and (p,2n) at 100 to 400 MeV, cross sections and product recoil ranges for, (E)
IRON-56 — proton reactions (p,n) and (p,2n) at 100 to 400 MeV, cross sections for, (E)
PROTONS — reactions (p,n) and (p,2n) with iron-56 and copper-63 at 100 to 400 MeV, cross sections for, (E)
— reactions (p,2p), (p,pn), and (p,2n) with tellurium isotopes at 300 MeV, cross sections for, (E)
TELLURIUM-122 — proton reactions (p,pn) at 300 MeV, cross section for, (E)
— proton reactions (p,2n) at 300 MeV, cross section for, (E)
TELLURIUM-123 — proton reactions (p,2p) at 300 MeV, cross section for, (E)
TELLURIUM-124 — proton reactions (p,pn) at 300 MeV, cross section for, (E)
— proton reactions (p,2n) at 300 MeV, cross section for, (E)
TELLURIUM-125 — proton reactions (p,2p) at 300 MeV, cross section for, (E)
— proton reactions (p,2n) at 300 MeV, cross section for, (E)
TELLURIUM-126 — proton reactions (p,2p) at 300 MeV, cross section for, (E)
— proton reactions (p,pn) at 300 MeV, cross section for, (E)
— proton reactions (p,2n) at 300 MeV, cross section for, (E)
TELLURIUM-128 — proton reactions (p,2p) at 300 MeV, cross section for, (E)
— proton reactions (p,pn) at 300 MeV, cross section for, (E)
TELLURIUM-130 — proton reactions (p,2p) at 300 MeV, cross section for, (E)
— proton reactions (p,pn) at 300 MeV, cross section for, (E) (L.T.W.)

37138 (RPI-328-160) LINEAR ACCELERATOR PROJECT. Progress Report, January 1–March 31, 1969. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 72p. Dep. CFSTI.

ALUMINUM — neutron spectra in assembly of, measurement of position dependent fast
ALUMINUM-27 — neutron inelastic scattering up to 20 MeV, γ spectra for, (E)

CADMIUM—neutron resonances below 1400 eV, spin assignments and widths for, (E)
COMPUTERS—interface for PDP-7 and IBM 1130 remote terminal of CDC-6600
HAFNIUM—neutron total cross sections of, at thermal energies, (E)
HAFNIUM-176—neutron total cross sections of, at thermal energies, (E)
HAFNIUM-177—neutron total cross sections of, at thermal energies, (E)
HAFNIUM-178—neutron total cross sections of, at thermal energies, (E)
HAFNIUM-179—neutron total cross sections of, at thermal energies, (E)
HAFNIUM-180—neutron total cross sections of, at thermal energies, (E)
LEAD-204—neutron radiative capture at 1 to 130 keV, cross sections and resonance parameters for, (E)
LINEAR ACCELERATORS—beam profile measurements at RPI electron, activation foil technique for
NEUTRONS—detection of, efficiency of boron-10 carbides sodium iodide scintillation detectors for
—detection of, design and performance of Moxon–Rae capture scintillation detectors for
NEUTRONS, FAST—spectra in aluminum, measurement of position dependent
—flux in depleted uranium, time dependence of
—flux distribution in depleted uranium, energy, space, and angle dependence of
—spectra in vicinity of major sodium resonance
REACTORS, FAST—transients in, space-time kinetics description of
—neutron flux and spectra in, pulsed assembly measurements on
PLUTONIUM-239—neutron resonances below 1400 eV, spin assignments and widths for, (E)
PLUTONIUM-240—energy levels from neutron resonances in plutonium-239, spin assignments for, (E)
RADIATION DETECTORS, SCINTILLATION—efficiency of boron-10 carbide sodium iodide, for detection of neutrons
—design and performance of Moxon–Rae capture, for detection of neutrons
RHODIUM-103—neutron resonances below 1400 eV, spin assignments and widths for, (E)
TUNGSTEN—neutron resonances below 1400 eV, spin assignments and widths for, (E)
URANIUM—neutron flux in pulsed fast assembly of depleted, time dependence of
—neutron flux distribution in pulsed fast assembly of, energy, space, and angle dependence of (H.D.R.)

37139 ISOMER RATIOS FOR THE $^{44}Ca(p,n)^{44m,g}Sc$ AND $^{85}Rb(p,n)^{85m,g}Sr$ REACTIONS. Sachdev, D. R.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem., 47: 1667-73(May 15, 1969).

Isomeric cross-section ratios for the $^{44}Ca(p,n)^{44m,g}Sc$ and $^{85}Rb(p,n)^{85m,g}Sr$ reactions were measured over a proton energy range of 6 to 85 and 6 to 27 MeV, respectively. Experimental results are compared with calculations based on the Vandenbosch–Huizenga formalism, while spin-cutoff parameter values were obtained from various models. For the isomeric pair of $^{44m,g}Sc$, the parameters required to obtain a good fit with the experimental results are in agreement with those of Keedy et al. On the other hand, the experimental results for the $^{85m,g}Sr$ isomeric pair are unusually high compared with the calculated isomer ratios. Half-lives of ^{44g}Sc and ^{85m}Sr were redetermined to be 4.05 ± 0.03 h and 68.0 ± 0.2 min, respectively. (auth) (CANADA)

37140 NUCLEAR DIFFRACTION OF RESONANT γ RADIATION BY AN ANTIFERROMAGNETIC CRYSTAL. Smirnov, G. V.; Sklyarevskii, V. V.; Voskanyan, R. A.; Artem'ev, A. N. JETP Lett. (USSR) (Engl. Transl.), 9: 70-3(Jan. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 123-7(Jan. 20, 1969).

A diffraction maximum due to nuclear resonance scattering was observed in reflection of Mössbauer radiation of ^{57}Fe in a hematite crystal. (J.W.R.)

37141 PARTIAL RADIATIVE CAPTURE OF RESONANCE NEUTRONS BY GOLD AND COBALT. Samour, C.; Alves, R. N.; Julien, J.; Morgenstern, J. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A130: 353-85(1969). (In French).

The direct capture process was studied in analyzing the variation of relative intensity with neutron energy for several transitions in gold and cobalt. For the 6245 keV transition in $^{197}Au + n$ and the 7490 keV transition in $^{59}Co + n$, the experimental data are consistent with the existence of a direct capture process. The cross section for such a process is respectively found equal to 1.5 ± 0.8 mb and 10 ± 3 mb at 1 eV. Clear positive interference effects were found for two other transitions in gold. Gamma ray spectra were also studied in detail for thermal neutrons and several individual resonances. (auth)

37142 SPECTROSCOPIC STUDIES IN THE A = 90 MASS REGION. II. NEUTRON HOLE STATES IN N = 49 NUCLEI. Bassani, G.; Picard, J. (CEN, Saclay, France). Nucl. Phys., A131: 653-72(1969).

Single neutron hole states in N = 49 nuclei were investigated using the (^{3}He, α) reaction on ^{88}Sr, ^{89}Y, ^{90}Zr, and ^{92}Mo, at 18 MeV bombarding energy. The energy resolution was of the order of 60 to 70 keV. States corresponding to the shell-model orbitals $1g_{9/2}$, $2p_{1/2}$, $2p_{3/2}$, and $1f_{5/2}$ were observed in all residual nuclei. Absolute differential cross sections were measured between 25° and 80° in 5 degree steps and analyzed using the Oak Ridge DWBA code JULIE. The dependence of the DW cross section on several parameters entering in the calculation of the form factor is investigated. The presence of configuration mixings in the residual nuclei is suggested by the excitation of more states than are predicted by shell-model considerations. In ^{89}Y the neutron states are weakly coupled to the odd proton configuration up to 1 MeV excitation energy. At higher excitation the coupling picture is more complicated. (auth)

37143 $^{89}Y(p,2p)^{88}Sr$ ANGULAR CORRELATION MEASUREMENTS AT 46 MeV. Richie, Kenneth (Univ. of California, Santa Barbara); Eisberg, Robert; Makino, Motoji; Waddell, Charles. Contracts AT(11-1)-34; AT(04-3)-136. Nucl. Phys., A131: 501-12(1969).

The angular correlation between protons from the ground state $^{89}Y(p,2p)^{88}Sr$ reaction, induced by the bombardment of 46-MeV protons, was measured for protons emitted at symmetric angles and coplanar with the incident protons. The ^{89}Y nucleus consists of a single $2p_{1/2}$ proton, that serves as the target in the ground state (p, 2p) reaction, outside a ^{88}Sr core, which is also the residual nucleus for this reaction. Thus these measurements concern a particularly simple (p, 2p) reaction. However, distortion effects are very important because of the low energies and large nuclei involved in the reaction. Therefore, the measurements should serve as a significant test for distorted-wave (p, 2p) reaction theories. (auth)

37144 REACTIONS OF ^{51}V AND ^{27}Al WITH 7 TO 120 MeV α-PARTICLES (EQUILIBRIUM AND NON-EQUILIBRIUM STATISTICAL ANALYSES). Bowman, W. W.; Blann, Marshall (Univ. of Rochester, N. Y.). Nucl. Phys., A131: 513-31(1969).

Excitation functions for formation of ^{54}Mn, ^{52}Mn, ^{51}Cr, ^{48}V, ^{47}Sc, ^{46}Sc, and ^{44m}Sc from ^{4}He ion bombardment of ^{51}V and of ^{22}Na and ^{24}Na from ^{4}He ion bombardment of ^{27}Al are reported. Incident ^{4}He ion energies varied between 7 and 120 MeV. Mean recoil ranges are reported for all products except ^{48}Sc. The experimental excitation functions are compared with standard statistical-model calculations, calculations using shell-dependent level densities due to Newton and to Rosenzweig, calculations in which compound nucleus and particle angular momenta are coupled using a spin-dependent level density, calculations in which the s-wave approximation is performed, and with Griffin's new non-equilibrium statistical model which includes intermediate resonances. No strong evidence is found for shell-structure effects on level densities in the ^{51}V region. The calculations with spin-dependent level density give satisfactory predictions of the positions and shapes of excitation functions over the energy span for which ranges indicate a compound nucleus mechanism, using a level density parameter of $\alpha = 1/8A$. The s-wave approximation is shown to get progressively worse with increasing excitation relative to the experimental results. The extreme high-energy tails shown by many of the excitation functions are reproduced reasonably well with varying admixtures of Griffin's precompound particle energy distribution. (auth)

37145 RADIATIVE NEUTRON CAPTURE IN THE REGION OF THE DIPOLE GIANT RESONANCE. I. EXPERIMENT. Cvelbar, F.; Hudoklin, A.; Mihailovic, M. V.; Najzer, M.; Ramsak, V. (J. Stefan Nuclear Inst., Ljubljana, Yugoslavia). Nucl. Phys., A130: 401-12(1969).

A scintillation technique for the measurement of the spectra of γ-rays following the capture of 14.1 MeV neutrons is described. The spectra are measured in the region of excitation energies from zero to the binding energy of the last neutron in the final nucleus for target nuclei Al, S, V, Cr, Mn and Fe. The spectrum of gamma rays obtained from the iron sample is compared with the spectrum measured at 7.4 MeV neutron energy. The difference between the shapes of the two spectra is in qualitative agreement with theoretical predictions. The cross section integrated over the measured energy interval is 410 ± 80 μb, 500 ± 100 μb,

730 ± 150 μb, 920 ± 180 μb, 780 ± 160 μb and 870 ± 170 μb for Al, S, V, Cr, Mn and Fe, respectively. The integrated cross sections are compared with cross sections measured by the activation techniques. (auth)

37146 ENERGY LEVELS OF ^{39}Ar. Bass, R.; Saleh-Bass, Fatma M. (Johann-Wolfgang-Goethe-Univ., Frankfurt am Main). Nucl. Phys., A131: 673-8(1969).

Levels of ^{39}Ar with $E_x < 3$ MeV were investigated via the reaction ^{39}K(n, pγ)^{39}Ar. Gamma-ray spectra were measured with Ge(Li) detectors in coincidence with protons. Several previously unresolved multiplets were found. Precise excitation energies and principal modes of gamma decay are given. (auth)

37147 SPECTROSCOPIC STUDIES IN THE A = 90 MASS REGION. I. THE (^{3}He,d) REACTION ON ^{88}Sr, ^{90}Zr, AND ^{92}Mo NUCLEI. Picard, J.; Bassani, G. (CEN, Saclay, France). Nucl. Phys., A131: 636-52(1969).

The proton states in neutron closed shell nuclei (N = 50) were investigated using the (^{3}He, d) reaction on ^{88}Sr, ^{90}Zr and ^{92}Mo at 18-MeV incident energy. Angular distributions of several deuteron groups up to 5 MeV excitation energy were measured between 25 and 80 degrees and compared with the predictions of DWBA reaction theory through the code JULIE in order to extract spectroscopic factors. Only one l = 4 transition was seen at low energy indicating a very small admixture of the $1g_{9/2}$ state. The observed l = 1 transitions show a rapid filling of the $2p_{3/2}$ and $2p_{1/2}$ sub-shell from ^{88}Sr to ^{90}Zr and no appreciable change from 90 Zr to ^{92}Mo. A very strong l = 2 transition around 3.5 MeV, observed in each reaction, marks presumably the beginning of the next major proton shell. (auth)

37148 RADIATIVE CAPTURE OF NEUTRONS IN THE REGION OF THE DIPOLE GIANT RESONANCE. II. CALCULATION. Cvelbar, F.; Hudoklin, A.; Mihailovic, M. V.; Najzer, M.; Petrisic, M. (J. Stefan Nuclear Inst., Ljubljana, Yugoslavia). Nucl. Phys., A130: 413-26(1969).

Spectra of γ-rays from the radiative capture of 14.1 MeV neutrons by the nuclei ^{32}S, ^{52}Cr and ^{56}Fe were calculated and compared with the experimental data. The calculation was performed according to three different formulations of the direct-semi-direct theory using neutron wave functions for the Woods-Saxon potential with spin-orbit coupling. The contribution to the γ-ray spectra from the capture via formation of the compound nucleus was also calculated. The results show that all three direct-semidirect models give reasonably good agreement with experiment in the excitation energy region 0– ≈ 5 MeV. At higher excitation energies, the direct-semidirect theory gives a much smaller cross section than the measured one. In this energy region, the capture via formation of the compound nucleus accounts for an appreciable part of the transition strength. (auth)

37149 THE INELASTIC SCATTERING OF NEUTRONS FROM ^{89}Y. Towle, J. H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Phys., A131: 561-73(1969).

A time-of-flight spectrometer was used to study the scattering of fast neutrons from ^{89}Y. Angular distributions for elastic and inelastic scattering were measured at 2.35 MeV, and excitation curves were measured at 0.2-MeV intervals from 1.6 to 3.8 MeV. The cross sections are in agreement with those obtained in earlier γ-ray measurements. The results are compared with calculations using the Hauser–Feshbach theory including the correction for the fluctuation of compound nuclear level widths, and good agreement is obtained. Previous J^π assignments of $9/2^+$, $3/2^-$, and $5/2^-$ to the 0.91, 1.51, and 1.75 MeV levels, respectively, are confirmed. The present results with information from other experiments show that the levels at 2.22 MeV and 2.53 MeV have J^π assignments $5/2^+$ and $7/2^+$, respectively, and that the 2.62-MeV level probably has $J^\pi = 9/2^+$. Possible assignments to the other levels observed are discussed. (auth)

37150 ABSORPTION OF γ QUANTA BY IRON NUCLEI NEAR THE GIANT RESONANCE. Dolbilkin, B. S.; Isakov, A. I.; Korin, V. I.; Lazareva, L. E.; Linkova, N. V.; Tulupov, B. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 675-9(Apr. 1969). (In Russian).

The total nuclear cross section of γ quanta absorption in Fe in the energy region 10 to 26.5 MeV was measured by the absorption method. The measurements were performed with bremsstrahlung spectrum ($E_{\gamma max}$ = 260 MeV). Photons were detected by a nine-channel magnetic pair spectrometer with the resolution ~1%. The integral cross section at 10 to 26.5 MeV was found to be $735^{+\frac{30}{40}}$ mbn·MeV. The cross section energy dependence is in agreement with the calculation using the dynamical collective model except for the resonance at 12.2 MeV with the half-width Γ ≈ 2 MeV and σ_0 = 160 ± 40 mbn·MeV. (auth)

37151 STUDY OF THE REACTION ^{28}Si(α,p)^{31}P IN THE ENERGY REGION OF PARTICLES FROM 11 UP TO 25 MeV. Zelenskaya, N. S.; Spasskii, A. V.; Teplov, I. B.; Fateeva, L. N. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 9: 691-701(Apr. 1969). (In Russian).

The reaction ^{28}Si(α,p)^{31}P was studied in the energy region of α particles from 11 up to 25 MeV. Excitation functions at eleven values of the proton emission angle and angular distributions at several values of α-particle energy were measured for three groups of protons corresponding to the lower energy state of the ^{31}P nucleus. Analysis of experimental results performed on the basis of the direct processes theory and of the statistical model of compound nucleus shows that in the investigated energy region one should take into account both mechanisms of the reaction. The excitation functions of the scattering ^{28}Si(α,α)^{28}Si at the angle 100° were measured in the energy region from 14 up to 25 MeV. (auth)

37152 EXCITATION OF ANALOG STATES IN THE SYSTEM ^{39}K + p. Vasilev, S. S.; Mikhaleva, T. N.; Chuprunov, D. L.; Shitikova, K. V. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 9: 686-90(Apr. 1969). (In Russian).

Excitation functions for α_0 and α_1 channels of the reaction ^{39}K(p,α)^{36}Ar and for p_1 and p_4 channels for the reaction ^{39}K(p,p')^{39*}K were measured simultaneously. In each function five resonances with the widths of some tens of keV's, correlating between the channels, were observed. The resonances observed are interpreted as a result of excitation in the ^{40}Ca compound nucleus of analog and double-analog states. (auth)

37153 EXCITEMENT OF ANALOGUE STATES IN REACTIONS ^{58} ^{60}Ni(d,n)^{59} ^{61}Cu. Okorokov, V. V.; Tolchenkov, D. L.; Cheblukov, Yu. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 710-14(Apr. 1969). (In Russian).

Isobaric analog states excited in the reactions ^{58,60}Ni(d,n)^{59,61}Cu were investigated. The spectroscopic factors were calculated by means of the distorted wave method. (auth)

37154 PROPERTIES OF THE ^{32}S NUCLEUS EXCITED STATES. Karadzhev, K. V.; Manko, V. I.; Chukreev, F. E. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 9: 742-9 (Apr. 1969). (In Russian).

Parameters of excited states of the ^{32}S nucleus in the excitation energy range 10.0 to 12.5 MeV were determined from the analysis of the energy dependence of cross sections of the elastic scattering ^{31}P(p,p)^{31}P and of the reactions ^{31}P(p,α_0)^{28}Si, ^{31}P(p,α_1)^{28}Si as well as from angular distributions of α-particles from these reactions. Momenta and parities of most of the states, partial and reduced proton- and α-particle widths of these states etc., were determined. Reduced α-particle widths are two orders of magnitude in the average larger than proton widths which indicates a strong association of nucleons in the ^{32}S nucleus. A group of states with reduced widths close to one-particle ones was observed in each of the two reactions studied, the distance between these groups being equal approximately to the energy of the first excited state of the ^{28}Si nucleus. It allows one to interpret the above states as excited states of ^{28}Si nucleus being either in the ground or in the first excited state, respectively. (auth)

37155 THE HALF-LIFE OF ^{47}Ca. Burkinshaw, L.; Marshall, D. H.; Oxby, C. B. (Univ. of Leeds, Eng.). Int. J. Appl. Radiat. Isotop., 20: 393-5(May 1969).

^{47}Ca decays through β-emission to the excited nuclear state of ^{47}Sc, which promptly emits gamma rays of energies 0.49, 0.81, and 1.29 MeV. ^{47}Sc then decays by β emission, with a half-life of 3.4 days, to ^{47}Ti, which emits a prompt gamma ray of energy 0.16 MeV. Reported values of the half-life of ^{47}Ca range from 4.3 to 5.35 days. Because of this uncertainty, and since the isotope is widely used as a biological tracer, a new value was determined by gamma-ray counting, using a sodium iodide scintillation detector. All observed counting-rates were corrected for changes in the gain of the equipment, and for contributions from random sum coincidence pulses. The mean value obtained was 4.5401 ± 0.0030 days. (auth)

37156 PRECISE ENERGY DETERMINATIONS OF γ-RAYS FROM ^{66}Ga. Strauss, M. G.; Lenkszus, F. R. (Argonne National Lab., Ill.). Nucl. Phys., A132: 195-203(1969).

A simple and precise technique for energy calibration of Ge(Li) γ-ray spectrometers was developed. The technique, which is particularly useful in studies of decay schemes, was used in measuring the energies of the γ rays present in the decay of 9.5-h ^{66}Ga. The high-energy lines were measured to a precision of 0.25 keV which is a significant improvement over previous measurements in which the uncertainties are 0.9 to 1.5 keV. The accuracy is demonstrated in a measurement of equal energy intervals of $2m_0c^2$ as a function of γ-ray energy. The standard deviation of the eight measured $2m_0c^2$ intervals was only 0.08 keV. The largest deviation from the mean was about 0.1 keV or less than 0.1 chan-

nel. The four high-energy γ-rays are particularly useful as calibration lines. Their energies in keV are 4086.18 ± 0.25, 4295.61 ± 0.25, 4461.59 ± 0.25, and 4806.58 ± 0.25. (auth)

37157 WIDTH OF THE 1.013 MeV LEVEL OF ^{27}Al. Hough, J. H.; Koen, J. W.; Celliers, P. J.; Mouton, W. L. (Univ. of Stellenbosch, South Africa). Nucl. Phys., A132: 110-22(1969).

The width of the $\frac{3}{2}^+$ 1.013-MeV level of ^{27}Al was determined in two nuclear resonant scattering experiments. In the first, the source of radiation was a 4000 Ci ^{60}Co source. Gamma rays of the desired energy were obtained by Compton scattering of the 1.33- and 1.17-MeV photons through a precalculated angle. This radiation was then scattered from an Al scatterer and the resonantly scattered quanta observed at an angle of 120° with respect to the incident beam. In the second experiment, Doppler-broadened γ rays emitted from the ^{27}Al(p,p′γ) reaction were used to excite the $\frac{3}{2}^+$ state. The weighted mean value of the level width was found to be Γ = 1.3 ± 0.4 MeV. This value is compared with various excited-core model calculations. (auth)

37158 LIFETIME OF THE 8.543-MeV LEVEL OF ^{28}Si. Lam, S. T. (Univ. of Toronto); Litherland, A. E.; Alexander, T. K. Can. J. Phys., 47: 1371-5(July 1, 1969).

The ^{25}Mg(α,nγ)^{28}Si reaction was used to measure the lifetime of the (6$^+$), 8.543-MeV level in ^{28}Si. The incident α-particle energy was chosen to be close to the threshold energy of the reaction, so that the directions of the recoiling nuclei were confined to a narrow cone. The 0°–90° attenuated Doppler shift of the 3.926-MeV gamma ray from the 8.543-MeV to the 4$^+$, 4.167-MeV level was measured with two Ge(Li) counters. The lifetime of the 8.543-MeV level was measured to 58 ± 12 fs. (auth) (CANADA)

37159 THE MEASUREMENT OF SOME (p,n) AND (p,2n) REACTION CROSS SECTIONS AT 400 MeV. Reuland, Donald J.; Caretto, A. A. Jr. (Carnegie-Mellon Univ., Pittsburgh). J. Inorg. Nucl. Chem., 31: 1915-21(July 1969).

Cross sections for (p,n) and (p,2n) reactions at 400 MeV were measured for targets of ^{52}Cr, ^{63}Cu, ^{77}Se, and ^{124}Te. The magnitude of the cross sections, and the σ(p,2n)/σ(p,n) ratio are compared with similar measurements on other target systems. A possible explanation for the trend obtained in the data is suggested. (auth) (UK)

37160 VARIATIONS OF THE TOTAL RADIATIVE WIDTH Γ_γ AS A FUNCTION OF MASS NUMBER A AND THE SPIN VALUE J = I ± ½. Julien, J.; Alves, R.; De Barros, S.; Huynh, V. D.; Morgenstern, J.; Samour, C. (CEN, Saclay, France). Nucl. Phys., A132: 129-60(1969). (In French).

Values of the total radiative width Γ_γ were measured for about 50 nuclei. Experiments were performed with the Saclay linear accelerator using the time-of-flight method. For some nuclei, Γ_γ is not constant from resonance to resonance. It is shown that variation of Γ_γ is due to the strong intensity of favored transitions for one spin state. A relation giving the value of the partial radiative width $\Gamma_{\gamma 1}$ is deduced from platinum results. It is applied to other nuclei to interpret the Γ_γ variations (Hg, Sn, Zr, Nb...). If the α-value of the quantity E_γ^α seems to be equal to five for $E_\gamma \approx 7$ MeV, this value is of the order of three for $E_\gamma \leq 4$ MeV. The average spacing level D is compared with theoretical predictions for the studied nuclei. The values of Γ_γ/D are so obtained. (auth)

37161 HIGH-ENERGY GAMMA RAYS OF ^{76}As FOLLOWING THERMAL AND EPITHERMAL NEUTRON CAPTURE. Groska, P.; Riehs, P.; Rumpold, K. (Reactor Center, Seibersdorf, Austria). Nucl. Phys., A132: 123-8(1969).

Using a Ge(Li) detector, the energies and intensities of the high-energy gamma transitions of the reaction ^{75}As(n,γ)^{76}As were measured. By comparison between gamma-ray intensities in thermal and epithermal neutron capture, 6 intense transitions are found to be due mainly to direct neutron capture. A classification of gamma-ray intensities after epithermal neutron capture indicated an E1 multipolarity for 8 gamma transitions. A determination of the binding energy, using the ^{36}Cl gamma energies for calibration, gave 7330 ± 4 keV. (auth)

37162 GAMMA-RAY SPECTRA ARISING FROM THERMAL-NEUTRON CAPTURE IN SILICON, CALCIUM, POTASSIUM, SODIUM, AND BARIUM. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 388-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37163 TITANIUM (n,p) CROSS-SECTION MEASUREMENTS. Lukic, Y. (Instituto Venezolano de Investigaciones Cientificas, Caracas); Carroll, E. E. Trans. Amer. Nucl. Soc., 12: 283-4 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37164 FAST NEUTRON RADIATIVE CAPTURE CROSS SECTIONS BY ISOTOPES ^{63}Cu, ^{65}Cu, AND ^{186}W. Zaikin, G. G.; Korzh, I. A.; Sklyar, N. T.; Totskii, I. A. At. Energ. (USSR), 25: 526-7(Dec. 1968). (In Russian).

The activation method was used for measuring the energy dependence of fast-neutron radiative capture cross sections of ^{63}Cu ^{65}Cu, and ^{186}W in the energy range 200 to 3100 keV. In order to eliminate absolute calculations of neutrons and β particles, the activities of fast and thermal neutrons were compared in the specimen examined. A fission chamber with ^{235}U was used as a monitor for comparing the fast and thermal neutron fluxes. Data obtained for the radiative capture cross sections are in agreement with published data. (R.V.J.)

37165 THE DECAY OF ^{71}Se. von Hundelshausen, Ulrich Frhr. (Univ., Goettingen, Ger.). Z. Phys., 225: 125-34(1969). (In German).

The decay of the 4.93-min ^{71}Se was investigated using Ge(Li) counters and a Ge(Li)–NaI(Tl) coincidence circuit. ^{71}Se was produced by bombarding targets of GeO_2 enriched in ^{70}Ge with 55-MeV α particles. Chemical separation was done. 8 γ-transitions in the energy range from 147.2 to 1,265 keV were found, and their relative intensities were determined. A level scheme for ^{71}Se → ^{71}As having 6 levels is proposed. (auth)

37166 SCATTERING OF 65-MeV ALPHA PARTICLES FROM ^{89}Y, ^{92}Zr, ^{94}Zr, ^{96}Zr, AND ^{116}Sn. Bingham, C. R. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Halbert, M. L.; Quinton, A. R. Phys. Rev., 180: 1197-1206(Apr. 20, 1969).

Differential cross sections for the scattering of 65-MeV α particles from ^{89}Y, ^{94}Zr, ^{96}Zr, and ^{116}Sn were measured at 1° intervals between 10° and ~75°. Angular distributions previously reported for ^{92}Zr were extended to 112°. Several Woods-Saxon potentials were found to fit each elastic angular distribution. Distorted-wave calculations for the inelastic scattering were made with collective-model form factors. The deformation lengths βR_0 are generally in agreement with the results of other experiments. Calculations using shell-model form factors were made for the 2$^+$ and 4$^+$ states in ^{94}Zr; a somewhat better fit to the data was obtained than with the collective model. (auth)

37167 DIPOLE GIGANTIC RESONANCE OF ^{43}Sc. Vershinin, G. A.; Gamalya, I. A.; Cherdantsev, P. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 102-4 (1968). (In Russian).

The diagonal part of the residual interaction in magic nuclei result in giant resonance and nondiagonal matrix elements result in a unique mixture of configurations. These effects are amplified in transition to nonmagic nuclei. Studies were made of nonmagic nuclei assuming that the ground state is a pure configuration, thus eliminating all other mechanisms appearing in mixed configurations. The studies were also limited to ordinary particle–hole aspects. The γ- and β-constants were determined on the basis of experimental data on the excited states of ^{42}Ca, ^{42}Se, and ^{50}Ti. Using the quasi-diagonal approximation, the problem was reduced to diagonalization of 9-dimensional matrices corresponding to different particle–hole excitations. Thus, the problem was reduced to studies of various core transitions appearing during particle–hole pair interactions with external nucleons. (R.V.J.)

37168 POLARIZATION AT ^{24}Mg (p,p) ^{24}Mg-SCATTERING IN THE 3- TO 4-MeV REGION. Soroka, V. I.; Cheborin, O. G. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 14: 162-3(Jan. 1969). (In Russian).

In the previous work L. J. Koester (Phys. Rev. 85: 643(1952)) assigned the spin and parity $\frac{3}{2}^-$ to the 5.304-MeV level of ^{25}Al produced by elastic proton scattering on ^{24}Mg at the resonance E_r = 3.14 MeV. The polarization of protons in ^{24}Mg(p,p)^{24}Mg scattering at 3 to 4 MeV was determined by the double-scattering method using a device which permitted simultaneous measurements of the polarization at two angles. A natural Mg isotope film 2 mg/cm^2 thick was used as a first target and ^{4}He as the second. Experiments were carried out in an electrostatic generator. The results obtained showed that the resonance E_r = 3.14 MeV is related to the capture of protons in the state l = 0, and the ^{25}Al 5.304-MeV level has spin and parity $\frac{1}{2}^+$. (R.V.J.)

37169 β SPECTROSCOPY OF ^{32}P, ^{48}Sc, ^{204}Tl, AND ^{210}Bi. Flothmann, D.; Wiesner, W.; Loehken, R.; Rebel, H. (Univ. Heidelberg). Z. Phys., 225: 164-94(1969). (In German).

A solid-state β-spectrometer using Si(Li) detectors in 4π geometry is described. The properties of the spectrometer were tested with several conversion electron and β-sources. Corrections due to systematic errors are discussed, and results on the β-spectra of ^{32}P, ^{48}Sc, ^{204}Tl, and ^{210}Bi(RaE) are presented. (auth)

37170 LIFETIMES AND BRANCHING RATIOS IN ^{49}Ti. Kavaloski, C. D. (Lowell Technological Inst., Mass.); Kossler, W. J. Contract AT(30-1)-2098. Phys. Rev., 180: 971-8 (Apr. 20, 1969).

The Doppler-shift attenuation method was used to study levels in ^{49}Ti up to 3.74-MeV excitation energy. Backscattered protons from the (p,p'γ) reaction were detected in coincidence with de-excitation γ rays. A 32-cc Ge(Li) detector was used to measure γ-ray Doppler shifts, and to obtain branching ratios. E even levels in ^{49}Ti were observed below 3.74 MeV. Transition rates in single-particle units are given for twelve transitions. The 0^+ level at 3.000 MeV was observed to decay with a transition rate of $(8 \pm 2) \times 10^{12}$ sec^{-1}, indicating a collective admixture for this state and suggesting that it is formed by the mixing of rotational and shell-model states. (auth)

37171 LEVEL STRUCTURE OF LOW-LYING EXCITED STATES OF ^{66}Ga POPULATED BY THE DECAY OF 2.2-h ^{66}Ge. Bolotin, H. H.; McClure, D. A. (Argonne National Lab., Ill.). Phys. Rev., 180: 987-96(Apr. 20, 1969).

The decay of 2.2-h ^{66}Ge to levels in ^{66}Ga was investigated by the use of both singles and coincidence γ-ray spectroscopic techniques that made exclusive use of high-resolution Ge(Li) detectors. The internal-conversion electron spectrum was also studied. A total of 23 transitions was observed in this decay; these were incorporated in a complete and unambiguous level scheme that differs markedly from those previously proposed. The excitation energies of the states in ^{66}Ga found to be populated in this decay are 43.8, 108.9, 204.0, 290.9, 381.8, 514.6, 536.6, and 706.0 keV. The half-life of the ^{66}Ge activity was redetermined to be 2.23 ± 0.10 h. The half-life of the first excited state was measured by delayed-coincidence techniques to be 21 ± 2 nsec. The multipolarities of many of the transitions were determined. Spin and parity assignments of many of the excited states were inferred, and severe limitations could be imposed on the spin assignments of the remainder of the levels. The log ft values of all β branches were established, and limits on the amount of isobaric-spin impurity present in the ground state of ^{66}Ge were set. The level characteristics were found to be consistent with expectations derived from theoretical considerations. (auth)

37172 STUDY OF THE LOW-LYING EXCITED STATES OF ^{29}Al. I. ^{30}Si(t,α)^{29}Al DIRECT-REACTION INVESTIGATION. Jones, A. D. W. (Lockheed Palo Alto Research Labs., Palo Alto, Calif.). Phys. Rev., 180: 997-1006(Apr. 20, 1969).

The ^{30}Si(t,α)^{29}Al reaction at a bombarding energy of 11.8 MeV was used to investigate the states of ^{29}Al up to 4.5-MeV excitation energy. From the deduced l values of the picked-up protons, the spin parity of the 1.40-MeV state is confirmed as $\frac{1}{2}^+$ and an assignment of $J^\pi = \frac{1}{2}^+$ is made to the 3.43-MeV level. The states at 2.88, 3.07, 3.65, 3.68, and 4.23 MeV are assigned $J^\pi = (\frac{3}{2}, \frac{5}{2})^+$. Tentative assignments of $(\frac{5}{2}^-, \frac{7}{2}^-)$ are made for both the 3.19- and 3.99-MeV states which are weakly excited in the experiment. Assuming that most of the proton pickup strength has been observed, the percentage occupation of protons in the ^{30}Si ground state is deduced to be $(1d_{\frac{5}{2}})^2 = 82\%$, $(2s_{\frac{1}{2}})^2 = 7\%$, $(1d_{\frac{3}{2}})^2 = 7\%$, and $(1f_{\frac{7}{2}})^2 \leq 4\%$. (auth)

37173 STUDY OF THE DECAY SCHEME OF ^{74}Br. Ladenbauer-Bellis, Inge-Maria; Bakhru, H. (Yale Univ., New Haven). Phys. Rev., 180: 1015-22(Apr. 20, 1969).

The decay scheme of ^{74}Br produced by ^{12}C ions (5.5 MeV/nucleon) on thin copper targets is discussed. The half-life was found to be 38 ± 1 min. The β^+ endpoint energy was measured to be 5.2 ± 0.1 MeV. For the determination of the γ rays, two Ge(Li) detectors were used and the following γ rays were established: 220 ± 2, 355 ± 2, 511, 610 ± 2, 633 ± 2, 722 ± 2, 835 ± 2, 985 ± 2, 1190 ± 5, 1220 ± 5, 1260 ± 5, 1355 ± 5, (1445 and 1455) ± 5, 1705 ± 5, 1960 ± 5, 2300 ± 10, and 3950 ± 15 keV. The weaker γ rays are listed in a table. A tentative decay scheme for ^{74}Br is given. (auth)

37174 OPTICAL-MODEL ANALYSIS WITH SPIN-ORBIT POTENTIAL FOR 30- AND 35-MeV ^{3}He ELASTIC SCATTERING. Luetzelschwab, J. W.; Hafele, J. C. (Washington Univ., St. Louis). Contract AT(11-1)-1760. Phys. Rev., 180: 1023-42 (Apr. 20, 1969).

Measured differential cross sections are reported for 30-MeV ^{3}He ions elastically scattered from ^{27}Al, ^{51}V, ^{59}Co, ^{60}Ni, ^{89}Y, ^{114}Cd, ^{115}In, and ^{116}Sn for angles between 6° and 165° and for 35-MeV ^{3}He ions elastically scattered from ^{59}Co, ^{60}Ni, ^{115}In, and ^{116}Sn for angles between 6° and 140°. The data are compared with predictions of the nuclear optical model, and potential parameters that produce optimum fits with a least-squares computer routine are reported. Good fits at back angles for ^{27}Al, ^{51}V, ^{59}Co, and ^{60}Ni are obtained only with the inclusion of a spin-orbit interaction with a magnitude between 2 and 5 MeV for most cases. The back-angle data for these nuclei also tend to suppress discrete ambiguities in the potential well depths. A continuous ambiguity between the radius and the diffuseness parameters is found to be related to a constancy of the root-mean-square radius. Effects of experimental uncertainties on the potential parameters are also presented. (auth)

37175 GAMMA-GAMMA COINCIDENCES AND GAMMA ANGULAR CORRELATIONS IN THE DECAY OF ^{69}Ge. Vasileva, N. God. Sofii. Univ., Fiz. Fak., 61: 37-47(1966-67). (In Russian).

As a result of the measured gamma-gamma sum-coincidences and angular gamma-gamma correlations a level scheme of ^{69}Ga is proposed. Detectors were scintillator counters with NaI(Tl) crystals. The measurements were done with a fast-slow coincidence circuit (τ = 20 ns). The spins of the following levels were determined: 320 keV $\frac{1}{2}$, 872 keV $\frac{5}{2}$, 1107 keV $\frac{3}{2}$. The 235-keV contains about 20% 872 keV-8% quadrupole components. The 552-keV transition is a pure quadrupole transition. (auth)

37176 MEASUREMENTS AND ANALYSES OF THE $S_{\frac{1}{2}}$ ANALOG RESONANCE IN THE ^{88}Sr(p,n)^{88}Y REACTION. Dutt, G. C.; Gabbard, F.; Schrils, R.; Egan, J. J. (Univ. of Kentucky, Lexington). Phys. Rev., 180: 1222-4(Apr. 20, 1969).

Experimental results for the total (p,n) cross section in the ^{88}Sr(p,n)^{88}Y reaction are presented for incident proton energies in the neighborhood of 6 MeV. Analyses are then made through explicit solutions of Lane's coupled equations and through comparison with Robson's theory. (auth)

37177 SPECTROSCOPY OF 1f-2p NUCLEI WITH DIRECT (d,α) AND (d,p) REACTIONS. I. ^{66}Cu AND ^{61}Ni. Daehnick, W. W.; Park, Y. S. (Univ. of Pittsburgh). Phys. Rev., 180: 1062-81(Apr. 20, 1969).

^{68}Zn(d,α)^{66}Cu and ^{65}Cu(d,p)^{66}Cu angular distributions were measured for deuteron energies of 12 MeV. The reaction products were magnetically analyzed, and the resolutions obtained were 11-12 keV for (d,α) and 8 keV for (d,p) reactions. Angular momentum transfers $L_{d,\alpha}$ and $l_{d,p}$ for the transitions were obtained by comparison with distorted-wave Born-approximation (DWBA) calculations. Level energies, J^π values or narrow limits for J^π, and (d,p) spectroscopic factors could be determined for about 65 ^{66}Cu levels below 3-MeV excitation. The reaction ^{63}Cu(d,α)^{61}Ni was investigated as a function of deuteron energy, $10.5 \leq E_d \leq 12.5$ MeV, in order to support the assumption that (d,α) reactions in this mass and energy range proceed by a direct transfer mechanism. A high-resolution ^{63}Cu(d,α)^{61}Ni spectrum and excitation functions for five well-resolved ^{61}Ni levels are presented. It is found that (d,α) cross-section fluctuations do not exceed counting statistics (<15%). The reported DWBA calculations follow current DWBA theories, without arbitrary parameters or cutoffs, and include corrections for finite range and nonlocality effects. Microscopic form factors based on finite-well single-particle wave functions were used for the ^{68}Zn(d,α)^{66}Cu calculations. Very good agreement with experimental (d,α) angular distributions was found if α potentials characterized by a real well with $r_0 \approx 1.4$ F, V ≈ 160 MeV were used. Shallower and deeper α-potential families which fitted elastic α scattering equally well were found to lead to quantitative and qualitative disagreement with experiment. (auth)

37178 SPECTROSCOPY OF 1f-2p NUCLEI WITH DIRECT (d,α) AND (d,p) REACTIONS. II. ^{64}Cu. Park, Y. S.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., 180: 1082-1104 (Apr. 20, 1969).

Levels of ^{64}Cu were studied with 12.08-MeV deuterons via the ^{66}Zn(d,α) reaction with 11-12-keV resolution and the ^{63}Cu(d,p) reaction with 7-8-keV resolution. About 85 levels were identified for $E_{ex} \leq 3$ MeV, i.e., 35 more than reported in the most recent literature. ^{66}Zn(d,α)^{64}Cu angular distributions were obtained over the range $15° \leq \theta \leq 90°$, and L values were extracted from comparison with distorted-wave Born-approximation (DWBA) calculations which incorporated finite-range and nonlocality corrections as well as microscopic form factors. Good agreement was found between the observed and calculated angular distributions. ^{63}Cu(d,p)^{64}Cu angular distributions were obtained over the range $8° \leq \theta \leq 50°$, and l values and spectroscopic factors were extracted from the comparison with DWBA calculations which included finite-range and nonlocality corrections and spin-orbit coupling for the bound neutron. It was possible to make unique 1^+ and 3^+ assignments for many levels from the recognition of L = 0 transfers, L mixing in (d,α) transitions, and overlap between (d,α) and (d,p) J^π limits. Good agreement in J^π assignments was found between the present work and (n,γ) work for almost all levels below 1-MeV excitation. (auth)

37179 SINGLE-PARTICLE AND CORE-COUPLED STATES IN ^{57}Co FROM THE DECAY OF ^{57}Ni. Gatrousis, C. (Univ. of

California, Livermore); Meyer, R. A.; Mann, L. G.; McGrory, J. B. Phys. Rev., 180: 1052-61(Apr. 20, 1969).

The decay of 36.0-h ^{57}Ni produced by the ^{54}Fe(α,n)^{57}Ni reaction was studied to obtain information on the level structure of ^{57}Co. γ-ray spectra were obtained with high-resolution Ge(Li) detectors, a Compton-suppressed Ge(Li) system, and Ge(Li)–NaI(Tl) $\gamma-\gamma$ coincidence spectroscopy. The γ-ray energies in keV (and the relative photon intensities) observed in this investigation are as follows: 127.1 ± 0.1 (200), 161.8 ± 0.3 (0.22), 252.5 ± 0.6 (≤0.4), 380.0 ± 0.2 (0.96), 673.4 ± 0.2 (0.58), 906.8 ± 0.3 (1.1), 1046.4 ± 0.2 (1.6), 1223.5 ± 0.4 (1.1), 1377.6 ± 0.2 (1000), 1730.6 ± 0.3 (0.72), 1757.6 ± 0.2 (77), 1896.5 ± 0.4 (0.28), 1919.5 ± 0.2 (170), 2132.9 ± 0.3 (0.47), 2730.6 ± 0.2 (0.3), 2803.9 ± 0.2 (1.7), and 3176.9 ± 0.3 (0.24). On the basis of Ge(Li)–NaI(Tl) coincidence experiments, energy sums, and earlier nuclear reaction data, levels in ^{57}Co were assigned at 0 ($\frac{7}{2}^-$), 1223.5 ± 0.4 ($\frac{9}{2}^-$), 1377.6 ± 0.2 ($\frac{3}{2}^-$), 1504.7 ± 0.2 ($\frac{5}{2}^-$), 1757.6 ± 0.2 ($\frac{3}{2}^-$), 1896.5 ± 0.4 ($\frac{5}{2}^-$), 1919.5 ± 0.2 ($\frac{5}{2}^-$), 2132.9 ± 0.3 ($\frac{5}{2}^-$), 2730.6 ± 0.2 ($\frac{5}{2}^-$,$\frac{3}{2}^-$), 2803.9 ± 0.2 ($\frac{3}{2}^-$,$\frac{5}{2}^-$), 3108.2 (≤$\frac{5}{2}^-$), and 3176.9 ± 0.3 ($\frac{5}{2}^-$) keV. The spin assignments are based on data from nuclear reaction studies, log ft values, and relative photon intensities. An attempt was made to explain the experimental results and the structure of ^{57}Co in terms of single-particle states and particle-plus-core states based on coupling the 2^+ collective core vibration to the $f_{\frac{7}{2}}$ odd proton hole. Previous work on ^{57}Co and ^{58}Co indicates that levels in ^{57}Co at 1223.5 ($\frac{9}{2}^-$), 1683 ($\frac{11}{2}^-$), 1757.6 ($\frac{3}{2}^-$), and 2132.9 ($\frac{5}{2}^-$) keV belong to a core-coupled multiplet. The γ-ray branching ratios are in agreement with this characterization of the states at 1223.5 and 1757.6 keV. (auth)

37180 M1–E2 MIXING RATIOS AND CONVERSION-ELECTRON PARTICLE PARAMETERS FOR ELECTROMAGNETIC TRANSITIONS IN ^{75}As. Becker, A. J.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1746. Phys. Rev., 180: 1043-8(Apr. 20, 1969).

Measurements were made of the $\gamma-\gamma$ and the conversion-electron–γ directional correlations of the 121–280-keV and the 136–265-keV cascades in ^{75}As following the decay of ^{75}Se. High-resolution Ge(Li) and Si(Li) detector systems were used exclusively, providing a significant degree of independence of these results from the effects of competing cascades. The Si(Li) electron spectrometer included a cooled field-effect transistor preamplifier to enhance its operation. The data are used to obtain the γ multipole mixing ratios δ and the internal-conversion particle parameters b_2 for transitions in ^{75}As. A precise definition of the mixing ratios in terms of reduced emission matrix elements is given in order to determine their sign unequivocally so that a comparison with theoretical predictions will be unambiguous. The results are δ(280-keV γ) = −0.392 ± 0.011, δ(265-keV γ) = −0.06 ± 0.02, b_2(E1; 121-keV K e^-) = −1.96 ± 0.04, b_2(E1; 136-keV K e^-) = −1.87 ± 0.23. These values for the mixing ratios are discussed in light of those obtained in other experiments, and a comparison is presented of the results for the particle parameters with the theoretical predictions based on the point- and finite-size-nucleus pictures. (auth)

37181 INNER-BREMSSTRAHLUNG SPECTRUM OF ^{55}Fe WITH A Ge(Li) DETECTOR. Kabasakal, Y.; Ramaswamy, M. K. (Fordham Univ., Bronx, N. Y.). Nuovo Cim., 61B: 220-4 (June 11, 1969).

The end point of the inner-bremsstrahlung spectrum in the electron-capture decay of ^{55}Fe was measured with a high-resolution (2.4 keV at 511 keV) Ge(Li) detector. The measured value of (218 ± 3) keV represents considerable improvement in precision over the earlier scintillation-counter value of (220 ± 10) keV. The resulting decay energy of (224.5 ± 3) keV is comparable in precision to the ^{55}Mn(p,n)^{55}Fe reaction value of (231 ± 2) keV. (auth)

37182 BETA- AND GAMMA-SPECTROSCOPY OF ^{80m}Br. Katoh, Toshio (Nagoya Univ., Japan); Morii, Tsuneo; Inoue, Hikaru; Yoshizawa, Yasukazu; Gotoh, Hiroshi; Sakai, Eiji. J. Phys. Soc. Jap., 26: 1071-4(May 1969).

Decay of ^{80m}Br was investigated. The half-lives of the isomeric and the ground states of ^{80}Br were obtained to be 4.42 ± 0.01 hr and 16.8 ± 0.1 min, respectively. Beta-ray, gamma-ray, and gamma–gamma coincidence studies were carried out, and energies and relative intensities of beta and gamma transitions were determined. Kurie plot analyses of negatrons and positrons give the maximum energies of 2.000 ± 0.016 and 0.850 ± 0.007 MeV, respectively. The 1.478-MeV 0^+ level of ^{80}Se and the 1.320 MeV 0^+ and 1.256 MeV 2^+ levels of ^{80}Kr were confirmed. (auth)

37183 EVIDENCE FOR A 0^+ LEVEL OF ^{54}Fe AT 2.56 MeV. Kreische, W.; Lampert, W.; Loos, G.; Weltle, D. (Univ., Erlangen-Nuernberg, Ger.). Phys. Lett., 29B: 170-1(Apr. 28, 1969). (In German).

Low-lying excited states in ^{54}Fe were investigated with the ^{54}Fe(p,p′$\gamma\gamma$)^{54}Fe reaction. The spin of the 2.56 MeV level was found to be J = 0. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 35049, 35253, 35497, 37105, 37108, 37113, 37117, 37126, 37134, 37135, 37137, 37138, 37141, 37142, 37147, 37159, 37160, 37162, 37164, 37166, 37169, 37174, 37286, 37290, 37329, and 37350.

37184 (AD-681729) GAMMA-RAY SPECTRA OF THE PRODUCTS OF THERMAL-NEUTRON FISSION OF ^{235}U AT SELECTED TIMES AFTER FISSION. Bunney, Leland R.; Sam, Daniel (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 16, 1968. 40p. (USNRDL-TR-68-144). CFSTI.

Experimental measurements of the gamma-ray spectra emitted by the products of thermal-neutron fission of ^{235}U were made at nine selected times ($\frac{1}{4}$, $\frac{1}{2}$, 1, 2, 5, 10, 24, 48, and 72 hours) after fission. A calibrated and highly collimated 5 in. × 5 in. NaI (Tl) detector was used. The 100-energy-bin gamma-ray spectra were unfolded from the pulse-height distributions by means of an iterative method. Extensive use was made of machine computation. The number of fissions in each sample was determined radiochemically. (auth) (USGRDR)

37185 (COO-1505-32) ANALYSIS OF THICK-TARGET RECOIL STUDIES OF HIGH-ENERGY NUCLEAR REACTIONS. Porile, N. T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Apr. 28, 1969. Contract AT(11-1)-1505. 24p. Dep. CFSTI.

The effect of broad velocity distributions on the vector model analysis of average projected ranges obtained in thick-target experiments was explored. The Monte Carlo technique was used to construct velocity distributions on the basis of impact and breakup velocity distributions inferred from differential recoil studies. A range–velocity relation for fission products in uranium was constructed and tested. Calculations were performed for ^{131}Ba, ^{99}Mo, and ^{103}Pd formed in the interaction of uranium with 2.2-GeV protons. (J.W.R.)

37186 (COO-1505-33) DEEXCITATION PROCESSES IN NUCLEAR REACTIONS. Progress Report, May 1968–April 1969. Porile, Norbert T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). May 1969. Contract AT(11-1)-1505. 26p. Dep. CFSTI.

BARIUM-134—alpha reactions (α,n) with cross sections and recoil ranges for, (E)
BARIUM-136—alpha reactions (α,3n) at 25 to 45 MeV, isomeric cross section ratio and recoil ranges for, (E)
BARIUM-137—helium-3 reactions (He-3,3n) at 15 to 30 MeV, isomeric cross section ratio and recoil ranges for, (E)
COPPER-65—alpha reactions (α,αn) at 20 to 42 MeV, differential range study of reaction mechanism for, (E)
FISSION FRAGMENTS—charge distributions and recoil properties from 11.5-GeV proton fission of lead-208 and uranium-238, (E)
LEAD-208—proton fission at 11.5 GeV, charge distribution and recoil properties of fragments from, (E)
URANIUM-238—proton fission at 11.5 GeV, charge distribution and recoil properties of fragments from, (E) (J.W.R.)

37187 (COO-1505-34) CHARGE DISTRIBUTION AND RECOIL PROPERTIES IN THE FISSION OF ^{238}U. Porile, N. T.; Panontin, J. A. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). May 29, 1969. Contract AT(11-1)-1505. 36p. Dep. CFSTI.

Cross sections and thick-target recoil properties were determined for a number of products in the mass region 100 to 115 from the interaction of ^{238}U with 11.5-GeV protons. The recoil ranges of the neutron-deficient products are nearly a factor of two smaller than those of the neutron-excessive products, suggesting a difference in reaction mechanisms. On the basis of this finding a charge dispersion curve consisting of two separate gaussians, peaking at N/Z = 1.22 and 1.40, was constructed to fit the measured cross sections. The curve associated with the neutron-excessive products is very similar to that obtained in the fission of ^{238}U by 450-MeV protons except for a reduction in the fission cross section by a factor of 2.4. The values of the average deposition energy, average total kinetic energy of the primary fragments, and average separation distance at scission obtained for these fragments from their recoil properties are nearly equal to the corresponding values at 450 MeV. Integration of the charge dispersion curve for the neutron-deficient products

indicates a 15% contribution to the total isobaric cross section at A = 111. The width of this distribution is less than half that of the curve for neutron-excessive products. Many of the properties of the neutron-deficient products are consistent with either spallation or fission of a nucleus in the heavy rare earth region, but neither mechanism can explain all the results. (auth)

37188 (IN–1182) AN EVALUATION AND COMPILATION OF ^{237}Np CROSS SECTION DATA FOR THE ENDF/B FILE. Smith, J. R.; Grimesey, R. A. (Idaho Nuclear Corp., Idaho Falls). May 1969. Contract AT(10-1)-1230. 85p. (ENDF–116). Dep. CFSTI.

This evaluation of ^{237}Np neutron cross-section data was undertaken as part of the effort by the Cross Sections Evaluation Working Group (CSEWG) to assemble the first version of the Evaluated Nuclear Data File B (ENDF/B). Graphs of calculated and experimental data from which the various files for this isotope were constructed are included along with complete documentation over the energy range from 0.00001 eV to 15 MeV. (auth)

37189 (IN–1296) RESONANCE INTEGRAL MEASUREMENTS. Schuman, R. P.; Berreth, J. R. (Idaho Nuclear Corp., Idaho Falls). May 1969. Contract AT(10-1)-1230. 24p. Dep. CFSTI.

Resonance integrals were measured for a number of nuclides by reactor activation inside cadmium shields. The values were determined relative to thin ^{197}Au (R.I. = 1558 b) and include the 1/v contribution from the thermal cross sections. Thin-sample resonance integrals were measured for: ^{55}Mn (14.0 ± 0.7 b), ^{59}Co (74.6 ± 3 b), ^{93}Nb (8.5 ± 0.5 b), ^{94}Nb (125 ± 8 b), ^{181}Ta (640 ± 60 b), ^{238}U (381 ± 30 b), ^{237}Np (807 ± 40 b), ^{243}Am (111 ± 10 b to 10.1 hr ^{244}Am, 2160 ± 120 b to both isomers), ^{241}Am (850 ± 60 b to 16 hr ^{242}Am, 250 ± 40 b to 152 yr ^{242m}Am), 152 yr ^{242m}Am (7000 ± 2000 b total), ^{242}Cm (150 ± 40 b to ^{243}Cm), ^{244}Cm (650 ± 50 b to ^{245}Cm), ^{245}Cm (680 ± 300 b total), and ^{246}Cm (110 ± 40 b to ^{247}Cm). Effective thick sample resonance integrals were measured for tantalum, cobalt, and gold. Some thermal cross sections and gamma-ray abundances were also obtained. (auth)

37190 (JINR–P4-4383) "SHELLS" IN NUCLEI WITH Z > 80. I. SHELL CORRECTION. Pashkevich, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 17p. (In Russian). Dep.

The shell correction was calculated for nuclei with Z > 80. The single-particle spectrum in the deformed potential with a diffuse edge was used. (auth)

37191 (KURRI-TR–10) NUCLEAR EXPERIMENTS WITH A REACTOR. Papers Presented at a Symposium, held on January 18–19, 1965, Kyoto Univ., Japan. Hayashi, Takeo (comp.) (Kyoto Univ. (Japan). Research Reactor Inst.). 167p. (In Japanese). (CONF-650125).

Separate abstracts were prepared for 8 of the 14 papers included. The remaining 6 papers were in summary form. (W.H.K.)

For abstracts of individual papers see: 35416, 35461, 35504, 37065, 37192, 37193, 37287, and 37288.

37192 (KURRI-TR–10, pp 3-19) PROBLEMS ASSOCIATED WITH NUCLEAR FISSION BY SLOW NEUTRONS. Katase, Akira (Kyushu Univ., Fukuoka (Japan)). (In Japanese).

Two of the most basic problems associated with fission by slow neutrons are discussed: nuclear fission cross sections and the mass distribution of the fission fragments. The compound nucleus and compound state of various target nuclei are tabulated for the various types of compound nuclei, mentioning also data on the subthreshold fission of ^{240}Pu, ^{238}Np, and ^{241}Am. It was found that the ratio between the mass distribution of nonsymmetric and symmetric fission varies with the resonant energy of the neutron. This variation and its explanation on the basis of the collective model are discussed in the light of experimental evidence to date. The fission of ^{233}U, ^{235}U, and ^{239}Pu was examined in greater detail. (TTT)

37193 (KURRI-TR–10, pp 66-70) MEASUREMENT OF CAPTURED γ RAYS. Nagahara, Teruaki (Rikkyo Univ., Yokosuka (Japan). Inst. for Atomic Energy); Kitao, Kensuke (In Japanese).

Thermal neutrons were used to study the captured γ rays of the rare-earth elements. The absorption of neutrons by the rare earth nucleus gave rise to an excited state, followed by the release of several of the 10-MeV level γ rays. While a good resolution unit, such as an electromagnetic spectrometer is desirable, it is costly and has very low efficiency. This problem may be overcome by using a high-efficiency spectrometer with an NaI crystal; however, in that case the wave-height distribution becomes very complex to make difficult the analysis of high energy γ rays. A counter coincident NaI spectrometer was used to follow (n,γ) reactions. The apparatus is diagrammed and described, and some of the results obtained with this apparatus are described. (TTT)

37194 (LIB/Trans–199) PRECISE COMPARISON BETWEEN MEDIUM, KINETIC ENERGY PARTICLES DURING THE SEPARATION OF THE ^{235}U EXCITED NEUTRONS AND THE NEUTRONS WITH 5-MeV AVERAGE ENERGY. Okolovich, V. N.; Smirenkin, G. N.; Bondarenko, I. I. Translated by Jack Kristo (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from At. Energ. (USSR), 12: 461-6(1962). 21p. Dep.

Twin ionization grid chambers were used in an investigation on the relationship between the mean kinetic energy of ^{235}U and the excitation energy of the nucleus being split. It was found that the mean kinetic energy of the particles during fission by thermal and 5-MeV neutrons coincided with an accuracy of ~0.1%. (auth)

37195 (PPAR–13) LEVEL STRUCTURE OF $^{116\ 118\ 120\ 122}$Te. Spejewski, E. H.; Hopke, P. K.; Loeser, F. W. Jr. (Princeton Univ., N. J. Palmer Physical Lab. Princeton Univ., N. J. Frick Chemical Lab. Princeton–Pennsylvania Accelerator, Princeton, N. J.). June 19, 1969. Contract AT(30-1)-2137. 35p. Dep. CFSTI.

The decays of ^{116,118,120,122}I were studied using isotopically separated sources produced by proton spallation of La. Ge(Li) γ singles spectra and Ge(Li)–Ge(Li) coincidence spectra were obtained and used in constructing level schemes for the corresponding Te daughters. (auth)

37196 (RT/FIMA–(68)4) A COMPILATION OF NUCLEAR DATA ON THE THERMAL FISSION PRODUCTS OF ^{233}U, ^{235}U, AND ^{239}Pu. Cenacchi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 78p. Dep.

Tables are presented on fission-product decay chains, thermal neutron fission yields, nuclear data of fission products, and products of neutron capture by fission products. (J.W.R.)

37197 NEUTRON RADIATIVE CAPTURE AND TRANSMISSION MEASUREMENTS OF W AND Zr ISOTOPES IN THE keV REGION. Bartolome, Z. M.; Hockenbury, R. W.; Moyer, W. R.; Tatarczuk, J. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng., 37: 137-56(July 1969).

Neutron capture and transmission measurements were carried out upon ^{182}W, ^{183}W, ^{184}W, ^{186}W, ^{90}Zr, ^{91}Zr, ^{92}Zr, and ^{94}Zr over the energy range from ~150 eV to ≤100 keV at the Rensselaer Polytechnic Institute LINAC Laboratory. Many new resonances were observed, and many resonances, reported previously as singlets, were resolved into doublets. Most of the resonances that previously eluded observation are assigned to p-wave neutrons. Pertinent resonance parameters were extracted from the data, and the s-wave and the p-wave strength functions of tungsten and zirconium were determined from these parameters. The values of the s-wave strength functions in units of 10^{-4} are: for ^{182}W, 2.60 ± 0.54; for ^{183}W, 2.41 ± 0.48 per spin state; for ^{184}W, 3.0 ± 0.6; for ^{186}W, 2.15 ± 0.46; for ^{90}Zr, 2.0 ± 1.4; for ^{91}Zr, 1.2 ± 0.4 per spin state; for ^{92}Zr, 2.6 ± 1.5, and for ^{94}Zr, 1.0 ± 0.8. The p-wave strength functions in units of 10^{-4} are: for the even-even tungsten isotopes, $0.28^{+0.09}_{-0.15}$; for ^{90}Zr, 7 ± 4; for ^{91}Zr, 3 ± 2 per spin state; for ^{92}Zr, 7 ± 5, and for ^{94}Zr, 4 ± 2. (auth)

37198 THREE-QUASIPARTICLE EXCITATIONS IN ^{175}Yb. Funke, L.; Kaun, K.-H.; Kemnitz, P.; Sodan, H.; Winter, G.; Bonitz, M.; Stary, F. (Central Inst. of Nuclear Research, Rossendorf, Ger.). Nucl. Phys., A130: 333-41(1969).

The level scheme of ^{175}Yb was investigated. In the decay of 15 min ^{175}Tm, single γ-ray spectra, γγ- and βγ-coincidence spectra were measured by means of Ge(Li) and scintillation detector spectrometry. Many new γ-ray transitions were observed. Several new levels above 1 MeV could be introduced into the ^{175}Yb level scheme, four of them probably being connected with three-quasiparticle excitations. An attempt to measure the lifetime of the strongly excited level at 1496.7 keV resulted in an upper limit of 0.1 ns. (auth)

37199 HARTREE–FOCK CALCULATION OF ^{208}Pb IN COORDINATE SPACE. Vautherin, D.; Veneroni, M. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., 29B: 203-6 (May 12, 1969).

The proton and neutron radii, densities, and single-particle energies, some local equivalent potentials, the overlaps of orbitals with harmonic oscillator wave functions, the Coulomb displacement energy are given and discussed for the interaction B1 of Brink and Boeker. (auth)

37200 PAIR EFFECTS AND NEUTRON–PROTON SURFACE DELTA REST INTERACTION IN SPHERICAL NUCLEI OF UNEVEN MASS NUMBERS. Baier, H. (Physikinstitut, Reaktorzentrum, Seibersdorf, Austria); Reya, E. Z. Naturforsch., 24a: 319-25(Mar. 1969). (In German).

Assuming a surface delta interaction (SDI) between identical as well as between nonidentical nuclei, the pairing properties of spherical odd mass (s.o.m.) nuclei were investigated in the regions

$40 \leq Z \leq 49$, $53 \leq N \leq 70$ and $51 \leq Z \leq 59$, $64 \leq N \leq 82$. Applying Bogoliubov's transformation to the neutrons and protons separately and applying the compensation principle gave the coupled system of BCS equations. Determining the quasi-particle energies and the chemical potentials of the neutron and proton system by numerical solution of these equations, impressive agreement between theory and experiment was found. For a SDI-model the incorporation of n-p forces seems to be both necessary and sufficient for a detailed understanding of the low-lying energy levels in the above-mentioned regions. In addition, the SDI-model has the advantage of analytic simplicity as compared to more refined realistic (multiparameter) models. (auth)

37201 DECAY OF 40 d ^{103}Ru AND 17 d ^{103}Pd TO LEVELS OF ^{103}Rh. Zoller, W. H.; Macias, E. S.; Perkal, M. B.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Nucl. Phys., A130: 293-304(1969).

The structure and properties of the levels of ^{103}Rh were further characterized by studying the electrons and γ-rays emitted in the decay of 40 d ^{103}Ru and 17 d ^{103}Pd. K-conversion coefficients of 0.0043 ± 0.0006 and 0.0025 ± 0.0005 were measured for the 497 and 610 keV γ-transitions respectively and indicate positive parity for the 537 and 650 keV levels. Using a time-to-amplitude conversion system, an upper limit of 0.4 ns was determined for the lifetime of the 93 keV level. Angular correlations were observed for the 444−53 and 557−53 keV cascades and indicate spins of $\frac{5}{2}$ or $\frac{7}{2}$ for the levels at 537 and 650 keV. A weak 242 keV γ-ray from the 537 level to the $\frac{3}{2}^-$ level at 295 keV establishes the spin and parity of the 537 keV level as $\frac{5}{2}^+$. The log ft values for the β^- decay and E. C. decay to the levels of ^{103}Pd were determined and sizeable hindrances noted. (auth)

37202 EXPERIMENTAL EVIDENCE FOR THE NUCLEAR STRUCTURE EFFECT IN INTERNAL CONVERSION OF N- AND O-SHELL ELECTRONS. Dragoun, O. (Nuclear Research Inst., Rez, Czech.); Plajner, Z.; Martin, B.; von Kap-Herr, A. Phys. Lett., 29B: 221-2(May 12, 1969).

Internal conversion line intensities were measured for the hindered 58 keV E1 transition in ^{180}Hf. Anomalies were observed for the N-subshell and O-total conversion coefficients and were explained with a nuclear current parameter $\eta = -6.5 \pm 0.7$ derived from the L- and M-subshell ratios. (auth)

37203 MEASUREMENT OF THE g-FACTOR OF THE 3^- OCTOPOLE VIBRATIONAL STATE IN ^{208}Pb. Bowman, J. D.; Zawislak, F. C.; Kaufmann, E. N. (California Inst. of Tech., Pasadena). Contract AEC AT(04-3)-63. Phys. Lett., 29B: 226-7(May 12, 1969).

The nuclear g-factor of the collective 3^- level at 2615 keV in ^{208}Pb was measured by the perturbed angular correlation technique. The result of $g(3^-) = 0.58 \pm 0.14$ confirms the strongly collective character of the state. (auth)

37204 ELASTIC SCATTERING OF ELECTRONS FROM LEAD AND BISMUTH AT 40 TO 60 MeV. Van Niftrik, G. J. C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A131: 574-600(1969).

Cross sections for the elastic scattering of electrons from natural lead and bismuth were measured relative to those of beryllium and carbon in the energy range 40 to 60 MeV. A phase-shift analysis with a static nuclear charge distribution of Fermi type yielded adequate fits to these data, for the parameter values (c, t, $\langle r^2 \rangle^{\frac{1}{2}}$) in fm (6.69 ± 0.08, 2.03 ± 0.17 and 5.46 ± 0.06) for lead and (6.75 ± 0.07, 1.95 ± 0.17 and 5.48 ± 0.05) for bismuth. Part of the data allows the determination of the r.m.s. charge radius almost independent of assumptions for the shape of the charge distribution. The r.m.s. radii agree with results of muonic X-ray data but show a small discrepancy with results of electron scattering performed at higher energies. The t-value for bismuth differs from one result of muonic X-ray data. A possible implication of this result, namely the recently suggested charge "halo" of the proton, is discussed. The differences of cross sections and of parameters for lead and bismuth are discussed separately. (auth)

37205 ON THE EXISTENCE OF THE ELECTRIC MONOPOLE COMPONENT IN THE $2^{+\prime} \rightarrow 2^+$ TRANSITION IN ^{192}Pt. Marinkov, L.; Anicin, I.; Bikit, I.; Stepic, R. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Phys., A131: 601-8(1969).

The $2^{+\prime} \rightarrow 2^+$ transition in ^{192}Pt was investigated. The ratio $K/L_3 = 8.90 \pm 0.05$ was measured on an iron-free double-focusing electron spectrometer, while the correlation coefficient $A_{22} = -0.018 \pm 0.006$ was determined on an electron-gamma directional-correlation spectrometer. From these values the quantity $q_K = 0.01^{+0.15}_{-0.14}$, was deduced. It was found that there is a high probability that $T_e(E0) = 0$ for the de-excitation of the second 2^+ state in ^{192}Pt. (auth)

37206 DECAY OF ^{243}Pu. Hoffman, D. C.; Lawrence, F. O.; Daniels, W. R. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A131: 551-60(1969).

The radiations associated with the β-decay of 4.96-h ^{243}Pu were studied with Ge(Li) and Si(Li) detectors and krypton- and xenon-filled proportional counters. Conversion electron lines of the more intense γ-transitions were measured, and tentative multipolarities were assigned. A decay scheme incorporating some 20 γ-transitions is presented. The Nilsson assignments of $\frac{7}{2}^+$ [624] for ^{243}Pu and $\frac{5}{2}^-$ [523] for ^{243}Am are substantiated by the data. The total β-disintegration energy of ^{243}Pu is 580 ± 10 keV. (auth)

37207 PHOTOFISSION OF EVEN-EVEN NUCLEI AND STRUCTURE OF THE FISSION BARRIER. Kapitza, S. P.; Rabotnov, N. S.; Smirenkin, G. N.; Soldatov, A. S.; Usachev, L. N.; Tsipenyuk, Yu. M. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.), 9: 73-6(Jan. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma v Redaktsiyu, 9: 128-32(Jan. 20, 1969).

The angular distributions of fission fragments from the photofission of ^{236}Pu, ^{240}Pu, ^{242}Pu, ^{232}Th, and ^{238}U were measured for bremsstrahlung end-point energies of 5 to 8 MeV. The data are analyzed in connection with the problem of the double-hump barrier. (J.W.R.)

37208 (t,p) REACTIONS ON $^{112\ 124}$Sn AND THE PAIRING MODEL. Bjerregaard, J. H. (Univ. of Copenhagen); Hansen, Ole; Nathan, O.; Chapman, R.; Hinds, S. Nucl. Phys., A131: 481-8(1969).

The (t, p) reactions on enriched targets of ^{112,124}Sn were studied at bombarding energies near 13 MeV. Sixteen states in ^{114}Sn and fourteen states in ^{126}Sn were observed. In both cases, the ground-state transitions were the strongest in the spectra. In ^{114}Sn, several transitions at $E_x \lesssim 3$ MeV had intensities between 10 and 20% of the ground state transition, whereas in the ^{126}Sn case no transitions below 5 MeV excitation had intensities above 7% of the ground-state transition. Two ^{126}Sn transitions at 5.31 and 5.76 MeV were of about 10% intensity, whereas in ^{114}Sn no transitions were observed above 3.7 MeV with appreciable (>5%) intensity. The data are discussed in terms of the pairing model. (auth)

37209 LEVELS OF ^{188}Os POPULATED BY ^{188}Ir AND ^{188}Re. Yamazaki, T.; Sato, J. (Tokyo Univ.). Nucl. Phys., A130: 456-80(1969).

The level scheme of ^{188}Os was studied from the decay of ^{188}Ir and ^{188}Re. The intensities and the locations of a number of gamma rays were determined with the use of Ge(Li) detectors. The multipolarities of most of the transitions were assigned on the basis of internal conversion coefficients. No rotational band based on the 1085 keV 0^+ state is observed. The higher excited states are discussed in terms of the independent quasiparticle model. (auth)

37210 THE LEVELS OF ^{91}Y FROM THE DECAY OF ^{91}Sr. Knight, J. D. (Los Alamos Scientific Lab., N. Mex.); Johnson, O. E.; Tucker, A. B.; Solecki, J. E. Nucl. Phys., A130: 433-48(1969).

The γ rays emitted in the decay of ^{91}Sr were studied by Ge(Li) singles and NaI(Tl) coincidence spectrometry, and energies and absolute intensities of 35 transitions were determined. A decay scheme is proposed involving ^{91}Y excited states at 555.6, 652.9, 925.8, 1186.9, 1305.4, 1473.7, 1545.9, 1580.0, 1980.4, 2066.7, 2206.9, 2279.4 and 2572 kev. The results of this experiment are combined with the direct reaction data of other investigators to assign spins and parities. The observed level structure is compared with previously reported predictions based on effective interaction calculations. (auth)

37211 SELECTED FISSION CROSS SECTIONS FOR ^{238}U. Davey, William G. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Sci. Eng., 36: 434-5(June 1969).

A recent measurement of $^{236}U/^{235}U$ fission cross-section ratios for fast neutrons is suggested as the best basis for ^{238}U cross sections. (J.W.R.)

37212 QUADRUPOLE ONE-PHONON STATES OF EVEN-EVEN NUCLEI IN THE REGION $150 \leq A \leq 174$. Korneichuk, A. A.; Malov, L. A.; Solovev, V. G.; Fedotov, S. I.; Schults, G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 750-9(Apr. 1969). (In Russian).

Energies and wave functions of the first two one-phonon states of the quadrupole type in even-even deformed nuclei are calculated on basis of the superfluid nuclear model and in framework of the approximate second quantization method. One-particle energies and the wave functions for the Saxon−Woods and Nilsson potentials in deformed nuclei are used in the calculations. Advantages of the calculations based on the Saxon−Woods potential as compared with these based on the Nilsson potential are indi-

cated. It is shown that for a prevailing number of the nuclei one obtains a reasonable description of the experimental energy values for the first $K^{\pi} = 2^{+}$ states and of the corresponding quantities B(E2) with one value of the constant $\varkappa^{(3)}A^{\frac{1}{3}} = 2.5$ MeV/cm^4 and with the effective charge value $e^{(2)}_{eff} = 0.2$. The obtained characteristics of the one-phonon states provide a basis for a further investigation of the structure of deformed nuclei. (auth)

37213 LONG-RANGE FISSION PARTICLES. Adamov, V. M.; Kovalenko, S. S.; Petrzhak, K. A.; Tyutyugin, I. I. Yadern. Fiz., 9: 732-9(Apr. 1969). (In Russian).

Ratios of the probability of the fission with the emission of long-range particles (LRP fission) of ^{232}Th, ^{233}U, ^{238}U, and ^{237}Np by 14-MeV neutrons to the probability of the LRP fission of ^{235}U by slow neutrons were determined. These are 0.3 ± 0.2, 1.2 ± 0.1, 0.64 ± 0.06, and 1.3 ± 0.1, respectively. Yields of protons and tritons in the fission of the above nuclei (except for ^{232}Th) by 14-MeV neutrons as well as in the fission of ^{233}U by slow neutrons and spontaneous fission of ^{244}Cm were measured. In all cases (except for ^{232}Th) spectra of α particles and tritons were measured. Proton spectra were measured in the fission of ^{235}U by slow neutrons and in the spontaneous fission of ^{244}Cm. Coincidences between a fragment and a long range particle were registered. The fragments were registered by a shallow ionization chamber, long-range particles were registered by a CsJ(Tl) crystal. Particle mass separation was made by the method of decay-time analysis in a crystal when registering the particles. The data obtained allow one to establish: probability of the LRP fission increases with the parameter Z^4/A; numbers of protons and tritons per 100 α particles lie within 2 to 4 and 5 to 14, respectively; maxima of α particles energy distribution lie at 16 MeV for all nuclei with corresponding value for protons and tritons is 8 to 9 MeV. Possible reasons for the variation of the probability of the LRP fission with the variation of Z^2/A and of the excitation energy are discussed. (auth)

37214 SPECTRA OF FISSION NEUTRONS OF ^{244}Cm, ^{242}Pu, AND ^{239}Pu. Belov, L. M.; Blinov, M. V.; Kazarinov, N. M.; Krivokhatskii, A. S.; Protopopov, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 727-31(Apr. 1969). (In Russian).

Spectra of neutrons of spontaneous fission of ^{244}Cm and ^{242}Pu as well as the spectrum of the neutron fission of ^{239}Pu by thermal neutrons were measured by the time-of-flight method. The spectra measured can be approximated by the Maxwell distribution $N(E) \sim E^{\frac{1}{2}}e^{-E/T}$. The dependence of the spectra mean energy on the mean number of emitted neutrons is in agreement with theoretical estimates. (auth)

37215 CHARGE AND ISOTOPE DISTRIBUTIONS OF FRAGMENTS FROM FISSION OF EXCITED NUCLEI IN REACTIONS WITH HEAVY IONS. Karamyan, S. A.; Oganesyan, Yu. Ts.; Penionskevich, Yu. E.; Pustylnik, B. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 715-26(Apr. 1969). (In Russian).

Charge and isotope distributions of fragments from fission of ^{238}U by the ions ^{12}C, ^{20}Ne, and ^{40}Ar were measured. It was established that the charge dispersion for fixed fragment mass increases with the parameter Z^2/A of the fissible excited nucleus at $Z^2/A > 38$. The fragment charge fluctuation is maximal for symmetric fission and decreases with the separation asymmetry. Dependence of the fragment charge dispersion on the excitation energy of the initial nucleus was measured for the reaction ^{238}U (^{20}Ne,f). The experimental results are shown to disagree with predictions of the statistical theory of the nuclear fission. (auth)

37216 α PARTICLE SCATTERING ON Pb ISOTOPES. Gonchar, V. Yu.; Zheltonog, K. S.; Ivanov, G. N.; Yushkov, A. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 9: 702-9(Apr. 1969). (In Russian).

Angular distributions of 40-MeV α particles elastically scattered on ^{206}Pb, ^{207}Pb, and ^{208}Pb nuclei in the scattering angle range 4 to 60° were measured. The phase analysis of the experimental data was performed in terms of the strong absorption model with broad edge of Akhiezer–Pomeranchuk–Blair (APB model). Within ambiguities which are analyzed in the paper, there is no isotopical effect in the parameters of the model. Various approximations of the APB model are also considered. (auth)

37217 STUDY OF THE DECAY OF THE ISOTOPES ^{121}Xe AND ^{123}Xe. Burmistrov, V. R.; Shilin, V. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 9: 673-4(Apr. 1969). (In Russian).

The decay of ^{121}Xe and ^{123}Xe was studied using a Ge(Li) γ spectrometer. In the ^{121}Xe decay new γ lines 302, 432, 1623, and 1773 keV were detected. Among 30 γ lines detected in the ^{123}Xe decay, 24 were observed for the first time. The intensities of all the γ transitions in ^{121}I and in ^{123}I were also measured for the first time. (auth)

37218 RESIDUAL INTERACTIONS AND PROPERTIES OF NUCLEAR STATES IN THE LEAD REGION. Hadermann, J.; Alder, K. (Univ., Basel). Helv. Phys. Acta, 42: 497-514 (May 16, 1969).

Introducing a residual interaction with a spin–spin and a tensor part, energy levels and transition probabilities of the three single-closed shell nuclei ^{206}Pb, ^{210}Pb, ^{210}Po were computed and compared with experimental data. The parameters of the residual interaction potential are close to the values known from nucleon-nucleon scattering data and from deuteron theory. (auth)

37219 CORRECTION FACTOR P(t) FOR FAST FISSION EFFECT MEASUREMENTS. Konishi, Toshio; Yamamoto, Hisashi (Hitachi Central Research Lab., Ozenji, Japan). J. Nucl. Sci. Technol. (Tokyo), 6: 243-7(May 1969).

The correction factor P(t) used in determining the fast fission effect of ^{238}U was measured in the range of cooling time t = 30 ~ 200 min for irradiations of 30 min, 2 and 5 hr, respectively. This factor depends quite sensitively on the bias level in γ-ray counting as well as on the irradiation time and cooling time after irradiation. It is emphasized that neglect of the dependence of P(t) on irradiation time and bias level results in a large error in measurements of fast fission effect of ^{238}U. (auth)

37220 AN ANALYSIS OF PRE-COMPOUND PARTICLES IN ^{116}Sn(p,n)^{116}Sb REACTION AT 14, 12, AND 10 MeV BOMBARDING ENERGIES. Parthasaradhi, K.; Rama Rao, J.; Visweswara Rao, V. (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 7: 205-6(Mar. 1969).

The ^{116}Sn(p,n)^{116}Sb reaction spectra at 14, 12, and 10 MeV were analyzed for pre-compound particles utilizing the expressions of J. J. Griffin [Phys. Rev. Lett., 17 (1966), 9]. It was found that the region of domination of the pre-compound particles increases as the bombarding energy increases. A qualitative explanation for the variation of nuclear temperature with the bombarding energy as well as with the residual excitation energy, is presented. (auth)

37221 FISSION OF Bi, Au, AND Pt NUCLEI DUE TO 40 TO 140 MeV PHOTONS. Ranyuk, Yu. N.; Sanin, V. M.; Sorokin, P. V. (Kharkov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 14: 409-17(Mar. 1969). (In Russian).

Yields of nuclear fission reactions for Bi, Au and Pt by bremsstrahlung were measured by means of solid state track detectors in the energy range from 40 to 140 MeV. The fission threshold for these nuclei is higher than the giant resonance energy which allowed total photofission cross sections to be calculated from the yield curves. A rapid increase of the cross sections with the photon energy testifies to the preference of the statistical model within which the fission thresholds of target nuclei were calculated. The results of the present experiment may be used to obtain information on the photon interaction mechanism in the energy region between the giant resonance and the threshold of meson production where this problem is still obscure. (auth)

37222 URANIUM QUADRUPOLE MOMENT BASED ON A DUAL CORE FISSIONABLE MODEL. Narayana, K. L. (Shivaji Univ., Kolhapur, India). Curr. Sci. (India), 38: 261-2(June 5, 1969).

An equation for the electric quadrupole moment of uranium is formulated assuming a dual core. For proper choices of the parameters, the equation will reproduce the experimental data. (J.W.R.)

37223 HALF LIFE OF THE 206 keV LEVEL IN ^{187}Re. Rajput, M. S. (Aligarh Muslim Univ., India). Curr. Sci. (India), 38: 263-4(June 5, 1969).

The half-life of the 206-keV level in ^{187}Re was measured with a delayed coincidence spectrometer in order to determine the retardation factor with respect to the single-particle estimate. (J.W.R.)

37224 SECONDARY REACTIONS PRODUCED DURING THE PREPARATION OF HAFNIUM BY NEUTRON ACTIVATION: ON THE DECAY OF ^{178}Lu. Balsenc, L.; Beeler, R.; Haerdi, W.; Monnier, D. (Univ., Geneva). Chimia (Aarau), 23: 154-5(Apr. 15, 1969). (In French).

A partial decay scheme is proposed for ^{178}Lu m in order to fit with experimental observation. A transition between the isomeric state and the ground state of ^{178}Lu is suggested. This hypothesis is verified mathematically. (auth)

37225 AN ENERGY-DEPENDENT CALCULATION OF THE ISOMER RATIOS OF ^{134}Cs PRODUCED IN THE FISSION OF ^{239}Pu BY MEDIUM-ENERGY PROTONS. Saha, G. B.; Yaffe, L. (McGill Univ., Montreal). J. Inorg. Nucl. Chem., 31: 1891-1905 (July 1969).

The isomer ratios of ^{134}Cs, produced in the fission of ^{239}Pu induced by protons of energies 30 to 85 MeV, were measured ex-

perimentally. Calculations based on a statistical theory of the spin distribution of the primary fragments were made for these isomer ratios. Competition between fission and neutron emission was taken into account in the calculations. The calculated isomer ratios were weighted with the relative formation probabilities of the pertinent fragments resulting from different fissioning nuclei. Values of $\sqrt{J^2}$, the root-mean-square angular momentum, which gave the best fit between the calculated and experimental isomer ratios, varied from 11ħ at 30 MeV to about 16ħ at 60–85 MeV. These large values of $\sqrt{J^2}$, which cannot be accounted for by the initial angular momentum of the fissioning nucleus, indicate that angular momentum must be induced in the fission process. The results also show that a fraction of the angular momentum of the fissioning nucleus appears as the intrinsic spin of the fragments. (auth) (UK)

37226 INDEPENDENT YIELD OF ^{135}I IN THE THERMAL NEUTRON FISSION OF ^{235}U. THE HALF-LIFE OF ^{135}Te. Denschlag, Hans Otto (Univ., Mainz). J. Inorg. Nucl. Chem., 31: 1873-82(July 1969).

The independent yield of ^{135}I in the thermal neutron fission of ^{235}U (47 ± 2% of chain yield) and the half-life of ^{135}Te (18 ± 2 sec) were determined using a rapid chemical isolation of fission iodine via ion exchange on a preformed AgCl precipitate. Chemical separation of iodine from its precursors could be performed within 2 sec after a short irradiation (0.05 sec). The result is discussed with respect to the effects of closed nuclear shells on charge distribution in fission. (auth) (UK)

37227 FORMATION OF ^{111}Pd ISOMERS IN NEUTRON FISSION OF SEVERAL HEAVY NUCLIDES. Aumann, D. C.; Flynn, K. F.; Gindler, J. E.; Glendenin, L. E. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 31: 1935-45(July 1969).

The cumulative yields of the ^{111}Pd isomers were measured in fission of ^{232}Th, ^{233}U, ^{235}U, and ^{239}Pu by neutrons. The ratios of the $^{11}/_{2}$ metastable state yield to the $^{5}/_{2}$ ground state yield were 0.0043, 0.0209, 0.0096, 0.0048, and 0.0186 for the respective nuclides. The estimated error in each value was ±10%. Independent yield isomeric ratios were calculated for various assumptions of charge distribution. The results of these calculations are discussed in terms of the parameters which describe the charge dispersion of mass-chain 111 and the angular momentum with which the fragments are formed. An upper limit of 0.43% was placed on the β-decay branch of ^{111}Rh–^{111m}Pd. (auth) (UK)

37228 MAGNETIC MOMENT OF THE 49.7 keV LEVEL IN ^{132}I. Singh, Vikram; Tandon, P. N.; Devare, S. H.; Devare, H. G. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A132: 221-4(1969).

The g-factor of the 49.72-keV level of ^{132}I was measured to be $g = +0.74 \pm 0.10$ from the rotation $\omega\tau$ of the angular correlation pattern of the 228.18–49.72 keV gamma-ray cascade in an external field of 19.5 kG. The spin of the level being 3^+, its magnetic moment is $\mu = 2.22 \pm 0.30$ n.m. This value of the magnetic moment agrees very well with the $(g_{^{7}/_{2}})_p\ (d_{^{5}/_{2}})_n$ assignment for the configuration of this level. (auth)

37229 RESONANCE NEUTRON CAPTURE IN ^{181}Ta(n,γ)^{182}Ta. Wasson, O. A.; Chrien, R. E.; Lone, M. A.; Bhat, M. R.; Beer, M. (Brookhaven National Lab., Upton, N. Y). Nucl. Phys., A132: 161-76(1969).

The γ-ray energies and intensities of the high-energy ($E_\gamma > 4.7$ MeV) γ rays emitted from neutron capture in tantalum for neutron energies less than 350 eV are measured with a Ge(Li) detector. The distribution of γ-ray intensities over seven capturing states is consistent with a χ^2 distribution with one degree of freedom, and the γ-ray transitions are uncorrelated with each other. The limitations of the values of the spins and parities of the final states populated by primary γ-ray transitions from the capturing states are inconsistent with previous spin assignments. (auth)

37230 LEVELS IN ^{183}Ta FROM THE DECAY OF ^{183}Hf. McIsaac, L. D.; Helmer, R. G.; Reich, C. W. (Idaho Nuclear Corp., Idaho Falls). Nucl. Phys., A132: 28-48(1969).

The γ and β radiations associated with the decay of 1.1-h ^{183}Hf were studied to provide information concerning the energy levels of the daughter nuclide, ^{183}Ta. The ^{183}Hf source was produced by thermal-neutron irradiation of a sample of isotopically separated ^{182}Hf($T_{^{1}/_{2}} = 9 \times 10^6$ y) made by the double-neutron capture process from ^{180}Hf. Beta-ray spectra and β–γ coincidences were studied with an anthracene detector and an anthracene NaI(Tl) coincidence system. The γ-ray spectrum was studied using a Ge(Li) spectrometer; and γ–γ coincidence measurements were made using NaI(Tl) detectors. The proposed decay scheme, which incorporates 21 of the 49 observed transitions, contains levels in ^{183}Ta (with I, K^π assignments) at the following energies: $0(^{1}/_{2},{}^{1}/_{2}^{+})$, $73.16(^{5}/_{2},{}^{3}/_{2}^{-})$, $143.19(^{3}/_{2},{}^{1}/_{2}^{+})$, $459.06(^{5}/_{2},{}^{3}/_{2}^{+})$, $572.8(^{7}/_{2},{}^{3}/_{2}^{+})$, $856.9(^{5}/_{2},{}^{3}/_{2}^{-})$, 1150.8 and 1543.4 keV$(^{5}/_{2},{}^{5}/_{2}^{-})$. The levels at 0, 73 and 459 keV are presumed to correspond to the Nilsson orbitals $^{1}/_{2}^{+}[404]$, $^{3}/_{2}^{-}[514]$, and $^{5}/_{2}^{+}[402]$. The ground state of ^{183}Hf has $I^\pi = {}^{3}/_{2}^{-}$ and presumably corresponds to the Nilsson orbital $^{3}/_{2}^{-}[512]$. The state at 856.9 keV is interpreted as a K-2 gamma-vibrational excitation built on the 73 keV level. The experimental data concerning this state are discussed in terms of its expected microscopic description and good agreement is obtained. (auth)

37231 DELAYED-NEUTRON HALF-LIVES FOR ^{233}U, ^{235}U, AND ^{239}Pu. Onega, R. J.; Rambo, G. E.; Huizinga, M.; Robeson, A. (Virginia Polytechnic Inst., Blacksburg). Trans. Amer. Nucl. Soc., 12: 289-90(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37232 SPECTRUM OF PROMPT GAMMA RAYS FROM THERMAL FISSION OF ^{235}U. Peelle, R. W.; Zobel, W.; Maienschein, F. C. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 384-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37233 THERMAL CROSS SECTIONS OF PLUTONIUM ISOTOPES AND THE 1968–1969 IAEA REVIEW. Leonard, B. R. Jr. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 226(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37234 MEASUREMENT OF NEUTRON FISSION AND ABSORPTION CROSS SECTIONS OF ^{239}Pu. Gwin, R. (Oak Ridge National Lab., Tenn.); Weston, L. W.; deSaussure, G.; Ingle, R. W.; Todd, J. H.; Gillespie, F. E.; Hockenbury, R. W.; Block, R. C. Trans. Amer. Nucl. Soc., 12: 260-1(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37235 CALCULATION OF NEUTRON-CAPTURE GAMMA-RAY YIELDS FOR TUNGSTEN AND NEUTRON INELASTIC-SCATTERING CROSS SECTIONS FOR IRON. Penny, S. K. (Oak Ridge National Lab., Tenn.); Yost, K. J.; White, J. Trans. Amer. Nucl. Soc., 12: 386-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37236 MEASUREMENT OF ^{239}Pu CAPTURE AND FISSION CROSS SECTIONS. Czirr, J. B. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 12: 261(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37237 DERIVATION OF ^{239}Pu RESONANCE PARAMETERS FROM CORRELATION OF EXPERIMENTAL DATA. Evatt, R. N.; Hutchins, B. A. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 262-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37238 MEASUREMENT OF PHOTOFISSION CROSS SECTION OF ^{239}Pu AND ^{239}Pu. Shapiro, A.; Stubbins, W. F. (Univ. of Cincinnati). Trans. Amer. Nucl. Soc., 12: 264-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37239 CALCULATION OF REDUCED GAMMA-RAY TRANSITION PROBABILITIES IN ^{239}Pu. Yost, K. J. (Oak Ridge National Lab., Tenn.); Pitkanen, P. H.; Fu, C. Y.; Long, E. C. Trans. Amer. Nucl. Soc., 12: 268(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37240 STATISTICAL TESTS FOR THE DETECTION OF INTERMEDIATE STRUCTURES IN THE FISSION CROSS SECTIONS OF ^{235}U AND ^{239}Pu. deSaussure, G. (Oak Ridge National Lab., Tenn.); Perez, R. B.; Moore, M. N. Trans. Amer. Nucl. Soc., 12: 269(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37241 THE RATIO $\sigma_\gamma(^{238}\text{U})\sigma_f(^{235}\text{U})$ IN THE NEUTRON ENERGY RANGE 30 TO 900 keV. Poenitz, W. P. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 279-80(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37242 NEUTRON FISSION AND CAPTURE CROSS-SECTION MEASUREMENTS FOR ^{233}U BELOW 1 eV. Weston, L. W. (Oak Ridge National Lab., Tenn.); Gwin, R.; deSaussure, G.; Ingle, R. W.; Todd, J. H.; Craven, C. W.; Hockenbury, R. W.; Block, R. C. Trans. Amer. Nucl. Soc., 12: 279(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37243 TOTAL NEUTRON CROSS-SECTION MEASUREMENTS OF $^{243\ 245\ 246}$Cm. Berreth, J. R. (Idaho Nuclear Corp., Idaho

Falls); Simpson, F. B.; Rusche, B. C.; Gregg, R. A. Trans. Amer. Nucl. Soc., 12: 280-1(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37244 TECHNIQUES FOR FAST FISSION CROSS-SECTION MEASUREMENTS OF CURIUM ISOTOPES. Barton, D. M.; Koontz, P. G. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 281-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37245 CORRELATION FOR CROSS SECTIONS OF THERMAL FISSION OF HEAVY NUCLEI. Romanov, Yu. F. At. Energ. (USSR), 26: 436-40(May 1969). (In Russian).

For the isotopes thorium to mendelevium the difference between bond energy of the last neutron B_n and the barrier E_f was calculated. For the definite sets of nuclei [$\Delta Z = 1$ and $\Delta(N - Z) = 1$] the differences $B_n - E_f$ are grouped within some average values. There is a correlation between fission cross sections of thermal neutrons and the values $B_n - E_f$ for compound nuclei, which differ in two units of Z and N. A comparison of periods for a spontaneous fission of even–even nuclei with the $B_n - E_f$ values is attempted. (auth)

37246 RADIATIVE CAPTURE CROSS SECTION OF FAST NEUTRON WITH ENERGY 0.2 TO 0.3 MeV BY NUCLEI ^{128}Te AND ^{130}Te. Dovbenko, A. G.; Kolesov, V. E.; Koroleva, V. P.; Tolstikov, V. A.; Shubin, Yu. N. At. Energ. (USSR), 25: 529-30(Dec. 1968). (In Russian).

The cross sections of ^{128}Te(n,γ)^{129g}Te and ^{130}Te(n,γ)^{131g}Te reactions for 0.2 to 0.3 MeV neutrons were measured by the activation method. A T(p,n)^{3}He reaction was used as a source of fast neutrons, and fission chamber with ^{235}U was used as a monitor. The activity was measured with a front-window β counter. The thermal cross sections of ^{128}Te($T_{\frac{1}{2}}$ = 74 min), 0.155 ± 0.040 barn, and of ^{130}Te ($T_{\frac{1}{2}}$ = 24.8 min), 0.220 ± 0.070 barn, were used for determining the cross sections of fast neutron capture. Data are included graphically on the cross sections of ^{128}Te(n,γ)^{129g}Te and ^{130}Te(n,γ)^{131g}Te. The magnitudes of the parameter a in the level densities formula were 13.5 and 11.85 MeV^{-1} for ^{128}Te and ^{131}Te, respectively. (R.V.J.)

37247 FISSION CROSS-SECTION OF ^{238}Pu BY FAST NEUTRONS. Ermagambetov, S. B.; Smirenkin, G. N. At. Energ. (USSR), 25: 527-9(Dec. 1968). (In Russian).

Previous studies of cross sections for ^{238}Pu fission by fast neutrons limited to 50 keV to 1.8 MeV, showed that at ~0.8 MeV σ_f reaches a plateau of 2.5 to 2.8 barns. The indicated magnitude σ_f is nearly 80% of the cross section of formation of the compound nucleus ^{239}Pu: $\sigma_f/\sigma_c (1 + \Gamma_n/\Gamma_f)^{-1}$. The ratio of the mean neutron and fission width Γ_n/Γ_f for the ^{239}Pu fission differs quite significantly for σ_c = 3.3 barn and σ_f = 2.65 barns. In order to verify the available data, the cross sections for ^{239}Pu fission were measured in relation to the fission cross sections of ^{235}U and ^{238}U. The obtained magnitudes for ^{238}Pu, $\sigma_f \approx$ 2.7 to 2.8 barns at 13 to 17 MeV, were in good agreement with direct measurements σ_c for targets ^{235}U, ^{238}U, and ^{239}Pu. (R.V.J.)

37248 AVERAGE OF INSTANTANEOUS NEUTRONS FROM SPONTANEOUS FISSION ^{242}Pu. Prokhorova, L. I.; Smirenkin, G. N.; Turchin, Yu. M. At. Energ. (USSR), 25: 530-1(Dec. 1968). (In Russian).

The number of instantaneous neutrons $\bar{\nu}$ per spontaneous fission of ^{242}Pu was measured by recording pulse coincidences in a neutron detector placed in the ionization fission chamber with the material examined. The detector consisted of 12 counters with ^{3}He in a cylindrical paraffin block. The counters were distributed concentrically around the block axis inside of which were placed layers of ^{242}Pu (0.4 mg) and ^{244}Cm (2.5 mg). The magnitude $\bar{\nu}$ for ^{242}Pu was measured in relation to the magnitude $\bar{\nu}$ for spontaneous fission of ^{244}Cm. The ratio of $\bar{\nu}$ for ^{242}Pu and ^{244}Cm was 0.787 ± 0.016. For ^{244}Cm $\bar{\nu}$ = 2.71 ± 0.04; for ^{243}Pu $\bar{\nu}$ = 2.13 ± 0.05. (R.V.J.)

37249 A MEASUREMENT OF THE FISSION CROSS SECTIONS OF ^{233}U, ^{235}U, AND ^{239}Pu. Keith, R. L. G.; McNair, A.; Rodgers, A. L. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Energy, 22: 477-86(Aug. 1968).

Precise values for the fission cross sections of ^{233}U, ^{235}U, and ^{239}Pu relative to the neutron capture cross section of ^{59}Co were obtained by irradiating thin foils in a well-thermalized flux of reactor neutrons. The 2200 m/s values were derived by the Westcott convention. The cross sections for ^{233}U and ^{235}U are based on a new measurement of the half-life of ^{233}U. (auth) (UK)

37250 THE NEUTRON CAPTURE CROSS SECTION OF GOLD IN THE keV ENERGY REGION. Poenitz, W. P.; Kompe, D.; Menlove, H. O. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Energy, 22: 505-15(Aug. 1968).

The capture cross-section shape of gold was measured in the energy range 25 to 500 keV and normalized at 30 keV using a "best fit"-value. The shape measurement was performed using a large liquid scintillator as a capture γ-ray detector and by means of a grey neutron detector which had a flat efficiency curve to measure the relative neutron flux. The results agree with recent measurements [Harris et al., Nucl. Phys., 69: 37(1965)], but disagree in the energy range above 130 keV with all measurements performed relative to the fission cross section of ^{235}U. (auth) (UK)

37251 THE HALF-LIFE OF ^{233}U. Keith, R. L. G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Energy, 22: 471-5(Aug. 1968).

The half-life of ^{233}U was found by two different specific activity determinations to be $1.553 \pm 0.010 \times 10^5$ yr. The number of atoms of ^{233}U was determined by mass analysis and the disintegration rate by low-geometry proportional counting. (auth) (UK)

37252 ELASTIC AND INELASTIC SCATTERING OF 155-MeV PROTONS ON ^{208}Pb. Willis, A.; Geoffrion, B.; Marty, N.; Morlet, M.; Tatischeff, B. (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 30: 13-16(Jan. 1969). (In French).

The cross section and the polarization of 155-MeV protons scattered by ^{208}Pb were measured. An optical model analysis is performed on the elastic scattering results, and the parameters are compared with previous values for ^{209}Bi. The results for the first excited state (3^- at 2.62 MeV) are interpreted in the distorted wave impulse approximation using Gillet's wave function. The collective character of this level seems not to be sufficiently taken into account by the model. (auth)

37253 μ-ATOMIC HYPERFINE STRUCTURE IN THE K, L, AND M LINES OF ^{238}U AND ^{232}Th. McKee, R. J. (Univ. of Chicago). Phys. Rev., 180: 1139-58(Apr. 20, 1969).

The μ-atomic hyperfine structure in the K, L, and M lines of ^{238}U and ^{232}Th was obtained using a large high-resolution Ge(Li) detector. The hyperfine structure is due to large deformations in these nuclei and arises from a dynamic electric quadrupole interaction between the muonic states and the lowest nuclear states. The measurements were interpreted using the Bohr–Mottelson rigid-rotator model with a symmetry axis for the nucleus and taking into account the first and second rotational states. The charge distribution chosen was a Fermi type whose constant-density shells are concentric ellipsoids of revolution of constant eccentricity. By numerically solving the Dirac equation, it was possible to determine three parameters of the size and shape of the nuclear charge distribution. The intrinsic quadrupole moments were found to be $(11.47 \pm 0.13) \times 10^{-24}$ and $(9.83 \pm 0.16) \times 10^{-24}$ cm^2 for ^{238}U and ^{232}Th, respectively, in good agreement with other measurements. The deformation parameter β was found to be 0.244 ± 0.002 and 0.222 ± 0.003, respectively. The central density, found to be 0.153 ± 0.002 and 0.153 ± 0.003 nucleons per cubic fermi, respectively, differs only slightly from the value of 0.158 nucleons per cubic fermi that one finds for most spherical nuclei. (auth)

37254 RESULTS OF A PARTICLE-HOLE MODEL FOR EVEN TIN ISOTOPES. Ottaviani, P. L. (Univ., Trieste, Italy); Savoia, M. Nuovo Cim., Lett., 1: 766-70(May 21, 1969).

Energy levels of the even Sn isotopes were calculated using a particle number conserving formulation of the BCS method. The results were compared with calculations using the standard BCS and Tamm–Dancoff approximations to evaluate the influence of particle number nonconservation on the physical properties. (J.W.R.)

37255 VELOCITY-DEPENDENT EFFECTIVE N–N POTENTIAL FOR SHELL-MODEL CALCULATIONS. Ganas, P. S.; McKellar, H. J. (Univ. of Sydney). Phys. Rev., 180: 953-6 (Apr. 20, 1969).

An effective N–N potential for shell-model calculations was previously obtained by modifying the velocity-dependent potential of Green to fit the low-lying energy levels of ^{18}O and ^{18}F. The low-energy spectra of ^{90}Y, ^{92}Zr, ^{210}Pb, and ^{210}Bi were calculated by this potential. On the whole, agreement with the experimental spectra is good. (auth)

37256 VARIATIONS OF NUCLEAR CHARGE RADII FROM K X-RAY ISOTOPE SHIFTS. Bhattacherjee, S. K. (Tata Inst. of Fundamental Research, Bombay). Proc. Nucl. Phys. Solid State Phys. Symp., 1968, Bombay, 1-10(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.1).

The recently developed atomic K x-ray isotope shift experiments are reviewed. The simplicity of interpretation of the data in extracting information about the variations of mean square charge radii of nuclei is stressed. Whenever possible, accurate relative optical isotope shifts are converted into absolute shifts

by utilizing these K isotope shift measurements. The variations of charge radii over a large number of isotopes as a function of neutron number for an element is discussed, particularly in cases like Sn, Nd, Hg, Hf, and Pb. Experimental results are compared with recent nuclear structure calculations. (auth)

37257 A MEASUREMENT OF THE RADIATIVE CAPTURE CROSS SECTION OF GOLD AT AN ENERGY OF 966 keV. Robertson, J. C.; Ryves, T. B.; Axton, E. J.; Goodier, I.; Williams, A. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy, 23: 205-10(Apr. 1969).

The $^{197}Au(n,\gamma)^{198}Au$ cross section was measured using a calibrated Na–Be photoneutron source. The ^{198}Au activity produced in the reaction was determined by absolute counting techniques. A value of 96.2 ± 2.0 mb for the cross section was obtained at the neutron energy of 966 keV. (auth) (UK)

37258 THE (p,t) REACTION ON THE EVEN ZIRCONIUM ISOTOPES. Ball, J. B. (Oak Ridge National Lab., Tenn.); Auble, R. L.; Roos, P. G. Phys. Lett., 29B: 172-5(Apr. 28, 1969).

The $^{90,92,94,96}Zr(p,t)$ reactions were studied with 38-MeV protons. An examination of the L = 0 transitions shows evidence for excitation of a pair-vibrational like state in the $^{92}Zr(p,t)^{90}Zr$ reaction. This type of state does not appear to be excited in the $^{94}Zr(p,t)$ and $^{96}Zr(p,t)$ reactions. The low-lying L = 0 transitions seem to be well accounted for in terms of a simple shell model picture. (auth)

37259 PARITY MIXING IN THE 482 keV TRANSITION OF ^{181}Ta. Bodenstedt, E.; Ley, L.; Schlenz, H. O.; Wehman, U. (Univ., Bonn). Phys. Lett., 29B: 165-6(Apr. 28, 1969).

The parity impurities in nuclear states of ^{181}Ta are investigated by measuring the circular polarization of γ rays in backscattering geometry. The value of the circular polarization obtained for the 482-keV transition is $P_\gamma = -(3.2 \pm 0.8) \times 10^{-5}$. (auth)

37260 A SET OF SINGLE-PARTICLE SELF-ENERGIES FOR THE N = 82 NUCLEI. Heyde, K.; Waroquier, M. (Rijksuniversiteit, Ghent). Phys. Lett., 29B: 147-9(Apr. 28, 1969).

A set of single-particle self-energies is calculated for the N = 82 singly closed-shell nuclei ^{139}La, ^{143}Pm, and ^{145}Eu using the inverse gap equations. Two-body matrix elements are calculated with a surface delta interaction. (auth)

37261 RESONANCE EFFECTS IN NEAR-BARRIER FISSION OBSERVED IN (d,pf) REACTIONS. Pedersen, J.; Kuzminov, B. D. (Univ. of Copenhagen). Phys. Lett., 29B: 176-8(Apr. 28, 1969).

The fission probability as a function of the excitation energy of the fissioning nucleus was measured for the reactions $^{233}U(d,p)^{234}U$, $^{235}U(d,p)^{236}U$, $^{239}Pu(d,p)^{240}Pu$, and $^{241}Pu(d,p)^{242}Pu$. In all these cases, the fission barrier lies below the neutron binding energy so that the only competition to fission is γ-decay which is known to vary smoothly with energy. The fission probability shows resonance structure below and at the fission barrier. One explanation for this resonance structure follows from the double-humped fission barrier. (auth)

37262 A STUDY OF LEVELS IN ^{92}Mo AND ^{94}Ru BY IN-BEAM GAMMA-RAY SPECTROSCOPY. Jaklevic, J. M.; Lederer, C. M.; Hollander, J. M. (Univ. of California, Berkeley). Phys. Lett., 29B: 179-81(Apr. 28, 1969).

Information is presented on the excitation energies, spins, parities, and lifetimes of excited states of the 50-neutron nuclei ^{92}Mo and ^{94}Ru, which are produced "in-beam" with $(\alpha,2n)$ reactions. The existence of a four-proton excited configuration, $(p_{\frac{1}{2}})(g_{\frac{9}{2}})^3$, is deduced from the data. (auth)

37263 CALCULATED ENERGY LEVELS FOR ^{92}Mo AND ^{94}Ru. Ball, J. B.; McGrory, J. B.; Auble, R. L.; Bhatt, K. H. (Oak Ridge National Lab., Tenn.). Phys. Lett., 29B: 182-4 (Apr. 28, 1969).

Previous energy level calculations for N = 50 nuclei are extended to include the levels for ^{94}Ru and higher-lying odd-parity states in ^{92}Mo. The results of these calculations are compared with recent experimental data for levels in these nuclei. (auth)

37264 PROPERTIES OF GAMMA TRANSITIONS IN ^{131}I. Vasileva, N. God. Sofii. Univ., Fiz. Fak., 61: 49-60(1966-67). (In Russian).

For the investigation of the gamma transitions in ^{131}I two scintillator detectors with NaI(Tl) crystals in a fast–slow coincidence circuit were used. The radioactive source was ^{131m}Te produced in a reactor. Gamma–gamma sum-coincidences and angular correlations were measured. From the results of these investigations an energy level scheme of ^{131}I is proposed. The energies and spins of the following levels were found: 0, $\frac{1}{2}^+$; 150 keV, $\frac{3}{2}^+$; 600 keV, $\frac{3}{2}$; 780 keV, $\frac{5}{2}$; 920 keV, $\frac{3}{2}$; 1130 keV, 1620 keV, $\frac{5}{2}$; 1920 keV, $1\frac{1}{2}$; and 2240 keV. Among them there were the following electromagnetic transitions: 150, 320, 450, 600, 780, 840, 920, 980, 1130, 1140, 1320, 1620, 1920, and 2240 keV. (auth)

37265 M/L ORBITAL-ELECTRON CAPTURE RATIOS IN ^{109}Cd DECAY. Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 180: 1220-1(Apr. 20, 1969).

A revised plot is presented of the comparison with theory of precision M/L orbital-electron capture ratios. The experimental points for ^{109}Cd and ^{113}Sn were relocated in accordance with the revised calculations of Vatai for L x-ray and K x-ray escape, respectively. From the revised plot, it is clear that there is a systematic disagreement of the experimental M/L capture ratios with exchange-corrected theory. (auth)

37266 INVESTIGATION OF GAMMA TRANSITIONS IN ^{129}I. Vasileva, N. God. Sofii. Univ., Fiz. Fak., 61: 27-35(1966-67). (In Russian).

Using a scintillation technique (single spectra, sum spectra, gamma–gamma coincidences, and gamma–gamma directional correlation measurements) the gamma transitions in ^{129}I were investigated. From the results of these investigations a level scheme of ^{129}I is proposed. (auth)

37267 HIGH-ENERGY-PROTON FISSION CROSS SECTIONS OF U, Bi, Au, AND Ag MEASURED WITH MICA TRACK DETECTORS. Hudis, J.; Katcoff, S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 180: 1122-30(Apr. 20, 1969).

The interaction of 0.6–29-GeV protons with U, Bi, Au, and Ag was studied with mica track detectors. Binary fission events were identified as correlated pairs of tracks. A fragment registered an acceptable track if its mass was ≥30 and its kinetic energy >6–8 MeV. The results show: The U fission cross section $\sigma_f(U)$ is 1400 mb up to 1.0 GeV and decreases monotonically to 670 mb at 29 GeV; $\sigma_f(Bi)$ increases from 125 mb at 150 MeV to a broad maximum of 215 mb at ~600 MeV, and then decreases to 105 mb at 29 GeV; $\sigma_f(Au)$ varies little, 59–76 mb, in the energy region 0.6–29 GeV (the highest values appear at 2 and 3 GeV); no binary events were observed from Ag targets: upper limits are 0.3 mb at 0.6 GeV, 2 mb at 1.0 GeV, 5 mb at 2–13 GeV, and 6 mb at 29 GeV. Effects of secondary particles were shown to be negligible; the experimental uncertainty varies from ±10 to ±20%. Ternary fission events (140) were seen for U starting at 1.0 GeV, and for Bi and Au starting at 2.0 GeV. The yields are about 1–2 per 1000 binaries. Many single unpaired tracks were also observed, and their yield increases with beam energy. From U, most of these seem to be from a small fraction of asymmetric fissions where one of the partners is below recording threshold. From Bi and Au, most of the single tracks are high-energy spallation residues. (auth)

37268 S-WAVE NEUTRON STRENGTH FUNCTIONS OF THE Gd ISOTOPES. Mughabghab, S. F.; Chrien, R. E. (Brookhaven National Lab, Upton, N. Y.). Phys. Rev., 180: 1131-8 (Apr. 20, 1969).

The neutron resonance structure of the gadolinium isotopes ^{155}Gd, ^{156}Gd, ^{157}Gd, ^{158}Gd, and ^{160}Gd was investigated over a wide energy region to determine the s-wave neutron strength functions, resonance parameters, and potential scattering radii. Values of the neutron strength functions as derived from an analysis of the average cross section in the keV region are found to be 2.4 ± 0.2, 1.9 ± 0.4, and 2.2 ± 0.2, all in units of 10^{-4}, for ^{155}Gd, ^{156}Gd, and ^{157}Gd, respectively. For ^{158}Gd and ^{160}Gd, the values, as obtained from the resonance parameters, are 1.6 ± 0.6 and 2.5 ± 1.3. In addition, the 2200-m/sec cross sections and absorption resonance integrals are computed and are compared with available experimental data. (auth)

37269 STUDIES OF ^{189}Os: GAMMA RAYS, LIFETIMES, AND MOESSBAUER EFFECT. Gregori, M. C.; Robinson, B. L.; Jha, S. (Case Western Research Univ., Cleveland). Phys. Rev., 180: 1158-66(Apr. 20, 1969).

The γ-ray energies and intensities in the decay of ^{189}Ir were measured with Ge(Li) and Si(Li) detectors, and the internal-conversion coefficients of 15 lines were estimated. The mean life of the 276-keV state was found to be less than 0.4 nsec by electronic means. Limits were established for the mean life of the 95.3-keV state by the Mössbauer effect (greater than 0.2 nsec) and by electronic means (less than 0.4 nsec). The mean

life of the 69.6-keV level was found to be 2.35 ± 0.06 nsec, and a single line of corresponding width was observed in the Mössbauer effect. The nuclear Zeeman effect gave the magnetic moment of the 69.9-keV state as 0.965 ± 0.020 μN, with E2/M1 = 0.57 ± 0.21 and an internal magnetic field of 1.085 ± 0.052 MG acting on the osmium nucleus in a dilute iron alloy. The electromagnetic properties of the 69.6-keV level are completely consistent with its pure rotational character. (auth)

37270 CHARACTERISTICS OF THE DIFFERENTIAL CROSS SECTIONS FOR THE LOW-ENERGY (p,n) REACTION ON THE SPIN-½ MEDIUM MASS NUCLEI. Kim, H. J.; Robinson, R. L.; Johnson, C. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., 180: 1167-74(Apr. 20, 1969).

The differential cross sections of neutron groups resulting from the bombardment of isotopically enriched ^{111}Cd, ^{113}Cd, ^{117}Sn, and ^{119}Sn targets with a 5.35-MeV pulsed proton beam were measured with a time-of-flight system. The observed angular distributions $\sigma(\theta)$ of the neutron groups feeding the low-lying residual states are all consistent with symmetry about $\theta = 90°$. They show the following distinct features which characterize the spin change $\Delta I = I_f - I_i$, where I_i and I_f are the spin values of the target and residual states: $\Delta I = 0$ transitions exhibit pronounced forward angle peaking; $\Delta I = 1$ transitions are isotropic; $\Delta I = 2$ transitions show mild peaking around 90°; the integrated differential cross section for $\Delta I = 1$ is greater than that for $\Delta I = 0$ for transitions from a given target nucleus leading to residual states with similar energies. A simplified consideration of the conservation of angular momentum and parity in the framework of the statistical theory of compound-nuclear reactions reveals that the characteristic shape of $\sigma(\theta)$ associated with the ΔI of a transition is a manifestation of the conservation laws. The experimental results also compare reasonably well with the theoretical predictions of the generalized Hauser–Feshbach theory of nuclear reactions. (auth)

37271 LOW-LYING STATES OF ^{111}In VIA THE ^{111}Cd(p,n)^{111}In REACTION. Kim, H. J.; Robinson, R. L.; Johnson, C. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., 180: 1175-6(Apr. 20, 1969).

A state of 801 ± 2 keV in ^{111}In was observed by the (p,n) reaction on ^{111}Cd. This was established from the neutron time-of-flight spectra as well as from the γ-ray spectra following the neutron emission. The incident proton energies ranged from 4.2 to 5.35 MeV. The angular distribution of neutrons and the preferential decay of this state to the spin-parity $\frac{1}{2}^-$ state at 535 keV show that the spin is $\frac{3}{2}$ or $\frac{5}{2}$, and most probably $\frac{3}{2}$. (auth)

37272 EMISSION TIMES AND YIELDS OF K X RAYS COINCIDENT WITH ^{252}Cf SPONTANEOUS FISSION. Dolce, Sanders R. (Rutgers–The State Univ., New Brunswick, N. J.); Gibson, Walter M.; Thomas, T. D. Phys. Rev., 180: 1177-86(Apr. 20, 1969).

Internal conversion is primarily responsible for most of the electron vacancies that give rise to x rays emitted by fission fragments of ^{252}Cf. The electronic transitions that fill these vacancies take place very quickly ($\approx 10^{-16}$ sec), while the x rays are emitted much later ($\approx 10^{-9}$ sec). Thus, the time of emission of fission x rays is determined by the nuclear transitions being converted. Both the number of x ray per fragment and the times at which they are emitted are important for understanding these transitions. Measurements were made of the yield per fragment and time of emission of K x rays coincident with ^{252}Cf fission, both as a function of fragment mass. The mean lives for emission of K x rays were measured using a time-of-flight technique. The measured x-ray yields are in substantial agreement with those obtained by other workers, and the spectrum of time versus mass is in excellent agreement with results obtained by Kapoor, Bowman, and Thompson using a very different technique. The results indicate that both the yields per fragment and mean lives are reflection-symmetric about a mass near the doubly magic nucleus of 50 protons and 82 neutrons. (auth)

37273 $\beta^+ - \gamma$ COINCIDENCE MEASUREMENTS IN THE DECAY OF ^{147}Gd. Adam, I.; Toth, K. S. (Univ. of Copenhagen). Phys. Rev., 180: 1207-10(Apr. 20, 1969).

A radioactive source that contained ^{147}Gd activity was used in a series of $\beta^+ - \gamma$ (NaI) coincidence measurements. The end-point energy of the β^+ component which feeds the 229-keV first excited state in ^{147}Eu was measured to be 1077 ± 25 keV, while its intensity was found to be (0.14 ± 0.03)% of all ^{147}Gd decays. The corresponding ^{147}Gd electron-capture decay energy was used in closed-energy-cycle calculations to predict the ^{151}Dy electron-capture energy (3001 ± 35 keV) and the ^{147}Gd α-decay energy (1847 ± 60 keV). (auth)

37274 SPECTROSCOPIC-FACTOR RATIOS FOR STATES OF THE SAME I–π FROM (d,p) REACTIONS AT DIFFERENT ENERGIES. Diehl, R. C.; Cohen, B. L.; Moyer, R. A.; Goldman, L. H. (Univ. of Pittsburgh). Phys. Rev., 180: 1210-12(Apr. 20, 1969).

In a previous study, ratios of spectroscopic factors from (d,p) reactions for l = 4 transitions to various $\frac{9}{2}^+$ states were found to vary strongly with bombarding energy in the Pd isotopes. As this represents a breakdown in basic one-nucleon-transfer theory, the possibility that this breakdown extends to l = 0 and l = 2 transitions was investigated in these isotopes. Measurements of ratios of spectroscopic factors for various transitions were made at 8-, 12-, and 17-MeV bombarding energies. The results at the three energies agree within experimental error, which indicates that the theory does not break down for these transitions. Differences in angular distributions for transitions with the same (n, l, j) to different nuclear states were noted in three cases. There is evidence that the ratio of cross sections for $d_{\frac{5}{2}}$ and $d_{\frac{3}{2}}$ excitations may vary much more between 8 and 12 MeV than is predicted by distorted-wave Born-approximation calculations. (auth)

37275 ISOBARIC ANALOG RESONANCES IN PROTON ELASTIC SCATTERING FROM ^{136}Xe. Moore, P. A. (Univ. of Texas, Austin); Riley, P. J.; Jones, C. M.; Mancusi, M. D.; Foster, J. L. Jr. Phys. Rev., 180: 1213-19(Apr. 20, 1969).

Isobaric analog states were observed in proton elastic scattering from ^{136}Xe at proton energies from 9.77 to 12.98 MeV. The observed levels in ^{137}Cs are identified as analogs of low-lying states of ^{137}Xe. The data were analyzed using a shell-model description of isobaric analog resonances. Orbital angular momentum transfer values, resonance energies, total and partial widths, and spectroscopic factors for most of the observed resonances are presented. The spectroscopic factors are shown to be highly insensitive to the choice of optical-model parameters. The results are compared with (d,p) studies on the target nucleus. The observed Coulomb displacement energy is 14.057 ± 0.040 MeV. (auth)

37276 ON THE ENERGY LEVELS OF ^{211}Bi. Gabrakov, St. God. Sofii. Univ., Fiz. Fak., 61: 19-26(1966-67). (In Russian).

The energies of ^{211}Bi levels made up of mixtures of $(g_{\frac{9}{2}})^2_{j_1}$, $h_{\frac{9}{2}}$; $J = \frac{7}{2}$ states and of $(g_{\frac{9}{2}})^2_{j_2}$, $h_{\frac{9}{2}}$; $J = \frac{9}{2}$ states were calculated. As far as the first excited state of ^{211}Bi is concerned, it was found that the first $(g_{\frac{9}{2}})^2_{j_1}$, $h_{\frac{9}{2}}$; $J = \frac{7}{2}$ level is considerably higher than the experimentally found level of 405 keV. One can suppose that this level is made up of a mixture of $(g_{\frac{9}{2}})^2_{j_1}$, $h_{\frac{9}{2}}$; $J = \frac{7}{2}$ and $(g_{\frac{9}{2}})^2_0$, $f_{\frac{7}{2}}$; $J = \frac{7}{2}$. From the calculation of the binding energy it is seen that the wave functions are not very bad but still have to be improved. (auth)

37277 INTERNAL CONVERSION STUDIES OF E2 TRANSITIONS AND THE LEVEL STRUCTURE OF ^{196}Pt. Jansen, Johannes Franciscus Wilhelmus (ed.). Amsterdam, Kleinoff-set Drukkerij Poortpers N. V., 1967. 110p.

Thesis.

The K conversion coefficients for E2 transitions in ^{152}Sm, ^{154}Gd, ^{160}Dy, ^{170}Yb, ^{196}Pt, and ^{200}Hg were measured by the internal-external conversion method. In addition, ^{170}Yb was studied by the x ray to γ-ray method. The level structure of ^{196}Pt was investigated through the decays of ^{196}Au and ^{196}Ir. (J.W.R.)

37278 ELECTRIC QUADRUPOLE MOMENTS OF EXCITED STATES OF EVEN–EVEN NUCLEI. Begzhanov, R. B.; Belen'kii, V. M. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 9, 18-20(1968). (In Russian).

Values for the electric quadrupole moments of 2^+ states in the ground rotational bands of ^{130}Ba, ^{112,114,116}Cd, ^{156}Gd, and ^{148,150,154}Sn were calculated using nonadiabatic theory and using the rotational–vibrational model. A comparison of the tabulated values calculated by the two methods shows little difference. (R.V.J.)

37279 ^{138}Ba(n,γ)^{139}Ba REACTION AND EVIDENCE FOR DIRECT CAPTURE. Moragues, J. A.; Mariscotti, M. A. J.; Gelletly, W.; Kane, W. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 180: 1105-13(Apr. 20, 1969).

The γ radiation emitted following thermal-neutron capture in ^{138}Ba was studied both in singles and coincidence with 9-cm^3 and 20-cm^3 Ge(Li) detectors and a 9-cm^3 Ge(Li)-NaI detector combination at the Brookhaven research reactors. γ rays of the following energies (in keV) and relative intensities (given in parentheses) were assigned to ^{139}Ba: 295 (<1), 352 (<1), 454.67 (27), 627.26 (100), 666.5 (1.5), 1047.4 (3), 1076 (<1), 1105 (2), 1420.1 (5), 1500 (<1), 1558.0 (2.5), 1854.0 (3), 1952.3 (3), 2242.0 (5), 2522.5 (2.5), 2537.0 (3), 2567 (3), 2594.1 (8), 3432 (<1), 3641.4 (20), and 4096.1 (60). All but one of these transitions were incorporated in a level scheme for the ^{139}Ba nucleus with levels at the following energies (in keV): 627.26 ± 0.10, 1081.9 ± 0.2, 1292.6 ± 1.0, 1420.1 ± 1.0, 1952.3 ± 1.0, 2129.3 ± 1.2, 2156.4 ± 2.0, 2186.4 ± 1.9, and 2481.4 ± 1.2. The level at 1292 keV which is excited in the ^{138}Ba(d,p) reaction is shown to be a doublet of

levels at 1284.0 and 1292.6 keV, of which only the 1292.6-keV member is observed to be populated in the $^{138}Ba(n,\gamma)$ reaction. The neutron separation energy was found to be 4723.4 ± 0.7 keV. The strengths of the primary γ rays and proton groups in the (n,γ) and (d,p) reactions, respectively, were compared, and a strong correlation, with a correlation coefficient of 0.95, was observed. This correlation is discussed in terms of the common unique parent assumption of Lane and Wilkinson. It is seen to be consistent with this assumption and yields evidence for direct capture. It is shown that the theory of radiative capture of Lane and Lynn predicts a cross section for direct capture in ^{138}Ba which is comparable to the observed total thermal-neutron-capture cross section σ_{th} = 0.35 ± 0.15 b. (auth)

37280 STUDY OF THE $^{90}Zr(d,p)^{91}Zr$ REACTION. Michelman, L. S.; Fiarman, S.; Ludwig, E. J.; Robbins, A. B. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., 180: 1114-22(Apr. 20, 1969).

Measurements were made of the differential cross section and polarization of protons from the ground state (l_n = 2) and the 1.2-MeV state (l_n = 0) in the $^{90}Zr(d,p)^{91}Zr$ reaction using 11-MeV deuterons. Measurements were also made of the elastic scattering cross section for 11-MeV deuterons and of the elastic scattering cross section and polarization for 14.8- and 16.0-MeV protons. An optical-model analysis was made of the elastic scattering results, and the potentials obtained were used in a distorted-wave Born approximation (DWBA) analysis of the (d,p) experiment. Except at forward angles, the DWBA calculation does not follow the trend of the polarization data for the protons from the 1.2-MeV state, where only the spin-orbit interactions contribute to the polarization. The polarization of the protons from the ground state was small at forward angles and could not be described by the DWBA analysis using the same geometrical parameters for the deuteron spin-orbit and real-central potentials. (auth)

Nuclear Theory

Refer also to abstracts 35545, 36871, 36954, 37135, 37200, 37245, and 37255.

37281 (AD–679762) ON THE WIGNER SUPERMULTIPLET SCHEME. Report No. 07591-3. Hecht, K. T.; Pang, Sing-Chin (Michigan Univ., Ann Arbor. Dept. of Physics). Sept. 1968. Contract Nonr-1224(59). 106p. CFSTI.

Calculation of Wigner and Racah coefficients for the group SU(4) contains (SU(2) × SU(2)) makes it possible to perform the spin, isospin sums in the cfp expansion of the matrix elements of one- and two-body operators in the Wigner supermultiplet scheme. The SU (4) coefficients needed to evaluate one- and two-particle cfp's, the matrix elements of one-body operators, and the diagonal matrix elements of two-body operators are calculated in general algebraic form for some many-particle states. Applications are made to the calculation of the matrix elements of the complete space scalar part of the Coulomb interaction and the space scalar part of the particle-hole interaction for nucleons in different major oscillator shells. (auth) (USGRDR)

37282 (AD–679763) FIVE DIMENSIONAL QUASISPIN CLASSIFICATION OF SHELL MODEL STATES IN THE SEMIORITY SCHEME. Report No. 07591-3-T. Hemenger, Richard P. (Michigan Univ., Ann Arbor. Dept. of Physics). Sept. 1968. Contract Nonr-1224(59). 105p. CFSTI.

Thesis.

States of configurations j (superscript N) of the nuclear shell model are classified using the properties of a five dimensional rotation group. A basis is used in which states of a given irreducible representation (specified by seniority and reduced isospin) are labeled with the physical quantum numbers N (nucleon number) and T, M sub T (isospin quantum numbers). A fourth quantum number is needed for a complete classification. Although there appears to be no fourth commuting operator which is either simple or of clear physical relevance, for all problems of practical importance this fourth number takes no more than two distinct values for fixed N, T and M sub T. It is shown how a complete classification can be made for these cases with results which are tractable and symmetrical under particle-hole conjugation. For the special case of seniority 2 and reduced isospin 1 the complete N,T dependence of matrix elements of the most general two-body interaction is found for an arbitrary j-shell or mixed configuration. This is carried out using a generalized Wigner–Eckart theorem. (auth) (USGRDR)

37283 (AD–682921) A CODE FOR CALCULATING NEUTRON COMPOUND-NUCLEUS CROSS SECTIONS AND ANGULAR DISTRIBUTIONS: JANE. Ferguson, James M. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 13, 1968. 57p. (USNRDL-CP–68-4). CFSTI.

A FORTRAN code is described which calculates the (n,n'), (n,p), and (n,α) cross sections due to compound nuclear processes. The code also calculates the angular distributions of neutrons and secondary gamma rays produced by inelastic scattering. A unique feature of the code is that the optical-model transmission coefficients needed for neutrons, protons and alpha particles are generated internally. A complete user's description is given. Also, several sample applications of the code are included, and some of the features and limitations of the physics of the code are discussed. (auth)(USGRDR)

37284 (AD–684735) RESEARCH IN EXPERIMENTAL AND THEORETICAL LOW-ENERGY NUCLEAR PHYSICS. Final Report, October 1, 1967–September 30, 1968. Davis, Robert H.; Heydenburg, Norman P. (Florida State Univ., Tallahassee. Dept. of Physics). Feb. 21, 1969. 72p. (AFOSR–69-421-TR). CFSTI.

Summaries of the work performed during the past year by six research groups are presented. The investigations of nuclear reactions and nuclear structure include studies of isobaric analogue states, interactions between complex nuclei, single and multiple nucleons transfer reactions, systematics of the $f_{\frac{7}{2}}$ shell, Coulomb excitation, level scheme determination by observation of short live activities, and meson induced charge-exchange reactions. Also included is a report on preliminary research in molecular collision physics. Indirect support is provided for a nuclear chemistry research, the results of which are cited herein. Facility improvements are discussed especially in the categories of ion source development and data handling by means of an on-line computer. (USGRDR)

37285 (CEA-CONF–1261) SPECTROSCOPY OF TRANSFER REACTIONS. DISCUSSION AND SUGGESTIONS. Harvey, B. (California Univ., Berkeley. Lawrence Radiation Lab. Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 2p. (In French). (CONF-690314–1). Dep.

From Conference on the Physics and Production of Heavy Ions, La Plagne, France.

The problems to be solved in spectroscopy by transfer reactions are illustrated by a brief discussion of the study of the mechanism by comparison between heavy ions and light particles and of the problems of energy transfer and angular momentum. Two examples are given of spectroscopy by heavy ions: excitation of pairing vibrations to several quanta and excitation of levels with large isospin. The problems to be solved in the study of transfer reactions accompanied by Coulomb excitation are considered. (J.S.R.)

37286 (COO–1051-33) OPTICAL POTENTIAL IN PROTON–NUCLEUS SCATTERING. Sianina, Donald A. (Michigan State Univ., East Lansing. Dept. of Physics and Astronomy). 1969. Contract AT(11-1)-1051. 72p. Dep. CFSTI.

Thesis.

The optical potential for 40-MeV protons is calculated for the spin zero nuclei ^{12}C, ^{40}Ca, ^{58}Ni, ^{120}Sn, and ^{208}Pb. The real central part of the potential is calculated to first order in the nucleon–nucleon effective interaction which is taken to be the G-matrix used in studies of the bound-state properties of finite nuclei. The impulse approximation is used for an estimate of the spin–orbit potential. The imaginary part of the optical potential is calculated from a perturbation treatment of the channels open for inelastic scattering. The energy dependence, isobaric dependence, effect of possible proton–neutron density differences, and antisymmetrization effects are considered for the real part of the central potential. Cross sections are calculated for the scattering of 20 and 40 MeV protons on ^{12}C and ^{40}Ca using the theoretical optical potential and are compared to cross sections obtained from empirical optical potentials. (auth)

37287 (KURRI–TR–10, pp 114-37) THREE PROBLEMS RELATED TO γ TRANSITION. Yoshizawa, Yasukazu (Osaka Univ. (Japan)). (In Japanese).

Gamma transitions play an important role in the study of nuclear structure, specifically in the determination of the spin level, parity, the multipolar nature of the transition and the determination of the transition probability. The reduced transition probability $B(E\lambda)$ and $B(M\lambda)$ can be determined from the half life, Coulomb excitation cross section, electron scattering, and resonant scattering of γ rays. On the other hand, there is no easy approach to determine the probability of very high excited states. The relative intensities of two or more γ rays emitted from the same excited state can be determined even when the measurement of the excitation probability presents difficulties. The reduced transition probability ratio $B(E\lambda, J \rightarrow J')/B(E\lambda, J \rightarrow J'')$ frequently describes qualitatively the properties of the collective excited states. The reduced probability ratios for the E2 transition are derived from

b vibrations and γ vibration states of deformed nuclei, examining the problems associated with transitions from high oscillator states (N ≥ 3) of quadrupole vibrations from spherical nuclei. Finally, the reduced probability of the E2 transition of collective excited states in the total mass region is discussed. There are insufficient experimental data for the E1 and E3 transitions. (TTT)

37288 (KURRI-TR-10, pp 138-49) THE MEASUREMENTS OF γ RAYS FROM EXTERNAL CONVERSION. Matsui, Hiroshi (Hyogo Univ. of Agriculture, Sasayama (Japan). Dept. of Physics). (In Japanese).

The measurement of γ rays by external conversion is shown to represent a very effective technique for checking the decay schemes of reactor-generated radioisotopes. This technique makes use of a β-ray spectrometer to measure external conversion electrons with good resolution. The γ rays can be measured with about the same precision as by internal conversion; the precision of the γ ray intensity measurements is within 5%. The same spectrometer may be used for measuring internal conversion electrons and to obtain the absolute value of the conversion coefficient, thereby determining the multipolarity of γ rays. By means of a conventional β-ray spectrometer of the source-converter system may be applied directly. It may be also used to calculate f-factors. (TTT)

37289 (N-69-22934) OPTICAL MODEL ANALYSIS OF PROTON SCATTERING IN THE RANGE 16 TO 22 MeV. Boschitz, Edmund T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1969. 37p. (NASA-TN-D-5067). CFSTI.

Polarization, differential cross section, and total reaction cross section data for the scattering of 16- to 22-MeV protons from complex nuclei were analyzed with the optical model. An average potential was obtained which describes most of the data. Deviations from the average spin-orbit potential were observed for nuclei with doubly closed shells. The analysis of the energy dependence of proton scattering from ^{16}O showed that a smooth variation of the optical model parameters results in satisfactory fits to the data between 30 and 50 MeV. The parameters cannot be extrapolated into the 20-MeV range. (auth) (STAR)

37290 (NYO-4032-3) RESEARCH IN THEORETICAL [NUCLEAR] PHYSICS. Progress Report. Brown, Gerald E.; Feingold, Arnold M. (State Univ. of New York, Stony Brook. Dept. of Physics). Apr. 1969. Contract AT(30-1)-4032. 61p. Dep. CFSTI.

BISMUTH-209 — energy levels of, core-excited, (T)
LEAD-207 — energy levels of, core-excited, (T)
LEAD-208 — energy levels of, coupling matrix elements for vibrational, (T)
— energy levels of, 4p-4h deformed, (T)
LEAD-209 — energy levels of, core-excited, (T)
NEON-20 — energy levels of, calculation for hole states, (T)
NUCLEAR THEORY — coupling between pouring vibration and phonon states in
POLONIUM-210 — energy levels of, calculation using Kuo matrix elements, (T)
THALLIUM-207 — energy levels of, core-excited, (T) (J.W.R.)

37291 (ORNL-tr-2164) INELASTIC INTERACTIONS OF HIGH-ENERGY DEUTERONS WITH ATOMIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-4346. 10p. Dep. CFSTI.

A cascade-evaporation model of deuteron-nucleus interactions with the account of stripping processes was considered by the Monte-Carlo method. In calculating the cascade the diffuseness of the nucleus boundary was taken into account and the energy-momentum conservation laws were exactly fulfilled. Meson-production processes were included into the theory and due to this fact one succeeded in advancing the energy region of >1 GeV. Good agreement with the whole amount of the available experimental data is pointed out. (auth)

37292 (OU-LNS-69-4) MAGNETIC MOMENTS AND β-DECAY ft VALUES OF MIRROR NUCLEI. Sugimoto, Kenzo (Osaka Univ. (Japan). Lab. of Nuclear Studies). [1968]. 12p. Dep.

Under the assumption that the isospin is a good quantum number, the available data on the magnetic moments and the β-decay ft values for isospin doublets were analyzed. A systematic information concerning the distribution of angular momentum between the orbital and the spin and between the protons and the neutrons of a nucleus was obtained for the mirror nuclei. A favorable evidence for the mesonic exchange effect to the magnetic moment was found. (auth)

37293 (UCRL-Trans-10344) NONLOCAL INTERACTION IN THE EFFECTIVE-FIELD EQUATION. ISOTOPIC SHIFT. Sapershtein, E. E.; Khodel, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated by T. Watt for Univ. of California, Lawrence Radiation Lab., Livermore, from report IAE-1426. 13p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 5942.

37294 A METHOD FOR CALCULATING THE GROUND-STATE PROPERTIES OF LIGHT CLOSED-SHELL NUCLEI. I. SOLUTION OF THE REACTION MATRIX EQUATION. Blank, J. (Charles Univ., Prague). Czech. J. Phys., 19: 572-88(1969).

A method for solving the reaction matrix equation in closed-shell nuclei using a spherical harmonic-oscillator representation is presented. The equation is transformed to an infinite algebraic system for the matrix elements, the exclusion operator being treated exactly. The system can be solved with arbitrary accuracy which depends only on the chosen truncation. (auth)

37295 FISSION CHIPS. Halpern, I.; Henley, E. M. Comments Nucl. Particle Phys., 3: 52-7(Mar.-Apr. 1969).

The process of charged particle accompanied fission is discussed. This type of fission appears to be only a minor variant of normal fission and suggests that fission is a more dynamic process than once believed. (J.W.R.)

37296 NUCLEON-NUCLEON CORRELATIONS IN NUCLEI. I. QUASI-DEUTERON PRODUCTION BY γ-RAYS. Brown, G. E. Comments Nucl. Particle Phys., 3: 48-51(March.-April 1969).

Nucleon-nucleon correlations in nuclei are examined in the case of quasi-deuteron production by γ-rays. It is shown the final-state interaction obscures the initial-state correlation. (J.W.R.)

37297 FURTHER STUDIES IN THE LIQUID-DROP THEORY OF NUCLEAR FISSION. Nix, James Rayford (Univ. of California, Berkeley). Nucl. Phys., A130: 241-92(1969).

The properties of the division of an idealized nucleus were studied using a simplified version of the liquid-drop model. The shape of the nuclear surface is specified by means of a parameterization that has six degrees of freedom, defined in terms of three smoothly joined portions of quadratic surfaces of revolution (e.g. two spheroids connected by a hyperboloidal neck). The system's Hamiltonian is treated in an approximation in which the potential energy is considered to be a sum of surface and Coulomb energies. The kinetic energy is calculated according to the method of Werner and Wheeler, which approximates the internal hydrodynamical flow by the flow of circular layers of fluid; this type of flow corresponds approximately to the irrotational flow of a non-viscous incompressible fluid. On the basis of this model, probability distributions for the masses and kinetic energies of the fragments at infinity were calculated. For nuclei throughout the periodic table, the calculated distributions are compared with experimental distributions as functions of the internal excitation energy of the compound nuclei undergoing fission. The comparisons indicate that this simplified version of the non-viscous irrotational liquid-drop model is not capable of accounting for the properties of the division of heavy nuclei at low excitation energies (e.g. for the observed mass asymmetry). However, it does reproduce approximately experimental fission-fragment mass and energy distributions for the fission of heavy nuclei at high excitation energies (energies above about 40 MeV) and medium-weight nuclei at all excitation energies. In all cases, the experimental kinetic energies and widths are larger than the calculated ones (for non-viscous irrotational flow), and this and other evidence suggest that in the fission process the flow of nuclear matter is either rotational or viscous. (auth)

37298 PROJECTION OPERATOR FOR THE SPURIOUS CENTRE-OF-MASS MOTION. Sebe, T.; Khanna, F.; Harvey, M. (Chalk River Nuclear Labs., Ont.). Nucl. Phys., A130: 342-52(1969).

A simple projection operator K is introduced that projects spurious states from a general harmonic oscillator shell-model state. The operator is used to define effective Hamiltonians which, in the example of the $J = 1^-$, $T = 0$ states of ^{16}O, appear capable of minimizing the contributions of spurious states to low-energy states in truncated bases. (auth)

37299 SPIN-DEPENDENT EFFECTS IN PROTON INELASTIC SCATTERING. Sherif, H. (Univ. of Washington, Seattle). Nucl. Phys., A131: 532-50(1969).

Proton inelastic collisions leading to the excitation of surface modes in even target nuclei are considered. An extension of the phenomenological optical model is made in which both the spin-independent and spin-dependent potentials contain terms linear

in the nuclear collective surface coordinates. The spin-dependent part has the full Thomas form. The T-matrix element is derived in the DWBA approximation, and expressions for inelastic observables such as cross section, polarization, asymmetry and spin flip probability are given. The theory is applied to the analysis of the inelastic scattering of protons in the energy range 29 to 50 MeV by several nuclei. Special attention is paid to the deformed spin-dependent interaction, where the full Thomas form is compared with a previously proposed simplified form. It is found that the use of the full Thomas form substantially improves the fit to the observed asymmetries, especially at forward scattering angles. Moreover, certain features of the measured spin-flip probabilities are reproduced only when the deformed spin-dependent interaction is of the full Thomas form. (auth)

37300 CHANGE OF THE DENSITY MATRIX FROM ADDITION OF A LARGE NUMBER OF PARTICLES TO A NUCLEUS. Osadchiev, V. M.; Troitskii, M. A. (Kurchatov Atomic Energy Inst., Moscow). Phys. Lett., 29B: 207-8(May 12, 1969).

A method is proposed to calculate the change in the single-particle density matrix from addition of a large number of particles. (auth)

37301 DENSITY DEPENDENT EFFECTS IN THE OPTICAL MODEL AND THE NUCLEAR MATTER RADII. Friedman, E. (Hebrew Univ., Jerusalem). Phys. Lett., 29B: 213-15 (May 12, 1969).

By adding to the reformulated optical model a density dependence of the interaction the discrepancy between the results of this model and the Coulomb displacement energies is removed. The results suggest that a neutron halo does not exist in heavy nuclei. (auth)

37302 TWO-HUMP FISSION BARRIER IN QUASICLASSICAL APPROXIMATION. Ignatyuk, A. V.; Rabotnov, N. S.; Smirenkin, G. N. (Inst. of Physics and Energetics, Obninsk, USSR). Phys. Lett., 29B: 209-10(May 12, 1969).

The penetrability of the fission barrier with two maxima is calculated. Its energy dependence shows characteristic resonance structure. Some experimental data on slow-neutron induced fission are discussed in terms of the model. (auth)

37303 NORMALIZATION OF SINGLE PARTICLE WAVE FUNCTIONS IN ATOMIC NUCLEI. Wegmann, G. (Univ. Munich). Phys. Lett., 29B: 218-20(May 12, 1969).

The normalization condition for single particle wave functions in finite Fermi systems is derived. (auth)

37304 NUCLEAR STRUCTURE USING THE PARTICLES OF HIGH-ENERGY PHYSICS. II. de Shalit, A. (Weizmann Inst. of Science, Rehovoth, Israel). Comments Nucl. Particle Phys., 3: 88-91(May-June 1969).

The use of high-energy electron scattering in studying dynamical correlations in nuclei is discussed. Problems in interpretation of data are described. (J.W.R.)

37305 DYNAMIC EFFECTS IN NUCLEAR PROBING BY MUONS. Halpern, I.; Henley, E. M. (Univ. of Washington, Seattle). Comments Nucl. Particle Phys., 3: 82-7(May-June 1969).

The state changes induced in the nucleus of a μ-mesic atom due to the presence of the muon are discussed. These dynamic effects include the volume change of the nuclear charge distribution and excitation of rotational states in deformed nuclei. (J.W.R.)

37306 NUCLEON–NUCLEON CORRELATIONS IN NUCLEI. II. π-MESON ABSORPTION, HIGH-ENERGY SCATTERING EXPERIMENTS. Brown, G. E. (State Univ. of New York, Stony Brook. NORDITA, Copenhagen). Comments Nucl. Particle Phys., 3: 78–81(May–June 1969).

It is pointed out that final-state interactions in nuclear reactions may significantly obscure initial-state nucleon–nucleon correlations. (J.W.R.)

37307 DEFORMED STATES IN LIGHT NUCLEI. Abgrall, Y.; Baron, G.; Caurier, E.; Monsonego, G. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys., A131: 609-22(1969).

The study of deformed structures in the light 4n self-conjugate nuclei is carried out using $(n_x n_y n_z)$ single-particle representation and the same effective interaction for all nuclei considered. In this work, the whole system of A nucleons is treated without any reference to a core. The rotational energy spectrum was calculated by projecting out good angular momentum states from the axially symmetric deformed Hartree–Fock states. In ^{9}Be and ^{20}Ne the low-lying states can be well described using a single deformed state, but this is no longer true in ^{28}Si. It is shown that the ^{12}C nucleus exhibits the same structure as observed in ^{16}O. In this nucleus the low-lying states are mixtures of 0p-0h, 2p-2h, and 4p-4h deformed states. The computed electromagnetic transition rates are compared to the experimental ones. A comparison with the SU_3 scheme is made. (auth)

37308 A NOTE ON THE SUM RULE FOR THE PARAMETERS IN MIGDAL'S THEORY OF NUCLEI. Baeckman, S.-O. (State Univ. of New York, Stony Brook). Contract AT(30-1)-4032. Nucl. Phys., A130: 427-32(1969). (NYO-4032-1).

The Pauli principle sum rule is violated if the interaction of quasiparticles in Landau's theory of normal Fermi liquids is calculated by functional differentiation of the binding energy obtained by Brueckner's method. The reason is the unsymmetrical treatment of particles and holes in Brueckner's theory. The fact that the phenomenologically determined values of Migdal's parameters also violate the sum rule is discussed. (auth)

37309 CORE EXCITATION IN SEMI-CLOSED NUCLEI. Goetz, U.; Hadermann, J. (Univ., Basel). Helv. Phys. Acta, 42: 389-96(May 16, 1969).

Four-particle–two-hole core excitation in nuclei with two nucleons outside the closed shells is treated by direct extension of the configuration space. Some applications to a simple two-level case are given. (auth)

37310 DIFFRACTION INTERACTION OF THREE-NUCLEON PARTICLES WITH NUCLEI. Berezhnoi, Yu. A.; Soznik, A. P. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 760-4 (Apr. 1969). (In Russian).

Diffraction interaction of ^{3}H and ^{3}He nuclei with nuclei resulting in their splitting in two or three particles is considered in adiabatic approximation as inelastic scattering of a point particle by a nonspherical potential. Formulas for differential cross sections of splitting of the ^{3}H and ^{3}He nuclei are obtained. (auth)

37311 THEORY OF NEUTRON-INDUCED DISINTEGRATION OF NUCLEI. Bhattacharyya, A. K. (Inst. of Theoretical Physics, Calcutta). Indian J. Theor. Phys., 15: 1-12(Mar. 1967).

A new theory of neutron-induced disintegration of nuclei, assuming a short-range extranuclear attractive potential of the Yukawa type, is presented. No Coulomb potential field exists; two potential regions are traversed by the neutron. The extranuclear field from the pseudoscalar meson theory falls off very rapidly outside the nuclear surface. If the variation of $1/r$ (where r is the distance from the center of the nucleus) is taken to be inappreciable in comparison with the variation of the exponential factor, the Yukawa potential can be taken as $U(r) = A \exp[-\mu(r - r_0)]$, where $A = A'/r$ is nearly constant. A thin spherical shell is assumed just within the nuclear surface with a constant attractive potential in this thin shell. The formula is treated in neutron absorption for 3 different target nuclei: ^{9}Be, ^{10}B, and ^{12}C. The total cross section derived is in the center-of-mass system, while the experimental observations are made in the laboratory system. Since the total cross section is the same in both, direct comparison of the theoretical formula with the experimental observations is possible. (BBB)

37312 ON THE SECONDARY SHELLS IN HIGHLY DEFORMED NUCLEI. Geilikman, B. T. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 9: 894-5(Apr. 1969). (In Russian).

In a previous work it was shown that the shells disappeared in the relatively low deformed nuclei ($\epsilon \approx 0.15$ to 0.2) reappeared with sufficiently increased deformations. The primary and secondary shells resulting in reduced nuclear energy appeared at $\epsilon \approx 0.6$. Such results were obtained for anisotropic oscillator and Nilsson models, and similar results were obtained for an ellipsoidal rectangular potential well. Calculations were made for the energy levels of the nuclei Th, U, and Pu in such models. Data obtained are related to the shell minima of magic or nearly magic (from the point of view of secondary shells) nuclei. With secondary shell saturation the minimum becomes smoother. Degenerate states were also observed at certain eccentricity magnitudes in the infinite ellipsoidal rectangular well; however, the latter proved much more complex than in the case of oscillator or Nilsson models. (R.V.J.)

37313 COORDINATES AND OBSERVABLES IN THREE-BODY PROBLEM IN NUCLEAR PHYSICS. Niri, Yu.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 882-93(Apr. 1969). (In Russian).

Coordinates and operators realizing representation of the SU(3) group on a six-dimensional sphere are constructed for the three-body system. A method to construct the spherical functions is given. Two types of the spherical functions are considered (K and A polynomials). (auth)

37314 CALCULATION OF THE EFFECTIVE MASS IN THE GEOMETRIC MODEL OF SYMMETRICAL FISSION. Stavinskii, V. S.; Rabotnov, N. S.; Seregin, A. A. (Inst. of Physics and

Power Engineering, Obninsk, USSR). Yadern. Fiz., 9: 779-82 (Apr. 1969). (In Russian).

The dependence of the effective mass of fissible nuclei on the distance between centers of gravity of fragments is calculated in terms of the drop model using the one-parametric geometric model of symmetrical fission. In all the stages of fission from initial sphere up to two-spherical fragments at infinity the effective mass is changed from 0.533 up to 0.25 of the total mass of fissible nucleus. The violation of the effective mass when calculating the barrier penetrability gives an increase of approximately 10% of the logarithm of the life time as compared to the spontaneous fission, but it does not affect the energy dependence of the penetrability. (auth)

37315 INFLUENCE OF FLUCTUATIONS OF PARTIAL WIDTHS ON COMPETITION BETWEEN FISSION AND INELASTIC SCATTERING. Rabotnov, N. S. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 775-8(Apr. 1969). (In Russian).

Fluctuations of fission and neutron widths around the mean values may in some cases influence qualitatively the results of analysis of the energy dependence of fission cross section for threshold elements. In the subthreshold region near the level of inelastic scattering some approximate relations are obtained. The relations indicate that at a small ratio of mean widths of inelastic and elastic neutron scatterings the competition of the inelastic scattering influence the fission cross sections much more essentially than may be expected from the observable excitation functions of the inelastic scattering. (auth)

37316 ADVANCES IN NUCLEAR PHYSICS. VOLUME 2. Baranger, Michel; Vogt, Erich (eds.). New York, Plenum Press, 1969. 442p. $18.50.

Separate abstracts were prepared for the five chapters included. (J.W.R.)

For abstracts of individual chapters see: 37317–37321.

37317 GIANT DIPOLE RESONANCE. Spicer, B. M. (Univ. of Melbourne). Advan. Nucl. Phys., 2: 1-78(1969).

The state of present knowledge about the giant dipole resonance is surveyed. Developments in the theory and in measurement techniques are traced in historical order. The giant dipole resonances of heavy nuclei are discussed in terms of the collective model while the particle-hole model is used for light nuclei. 145 references. (J.W.R.)

37318 POLARIZATION PHENOMENA IN NUCLEAR REACTIONS. Glashausser, C. (Univ. of California, Berkeley); Thirion, J. Advan. Nucl. Phys., 2: 79-128(1969).

A review is presented of what has been learned from polarization measurements in nuclear reactions. A critical discussion of polarized sources and polarized beams is presented. The elastic and inelastic scattering measurements as well as transfer reaction data are surveyed. The type of information that may be expected in the near future is discussed. (148 references) (J.W.R.)

37319 PAIRING-PLUS-QUADRUPOLE MODEL. Bes, Daniel R.; Sorensen, Raymond A. (Carnegie-Mellon Univ., Pittsburgh). Advan. Nucl. Phys., 2: 129-222(1969).

The use of the pairing-plus-quadrupole force to include individual particle and collective aspects in systematic calculations for all nuclei is discussed. The model is a one-body shell model with pairing and quadrupole forces as residual two-body interactions. The foundation, computational techniques and approximations, and the successes of the model are reviewed. (J.W.R.)

37320 NUCLEAR POTENTIAL. Signell, Peter (Michigan State Univ., East Lansing). Advan. Nucl. Phys., 2: 223-94(1969).

The problem of the formulation of a nuclear potential is surveyed. The two nucleon data and the proton-proton bremstrahlung data and their implications are described. Several phenomenological and semi-phenomenological potentials are discussed. The possibilities of describing the nuclear force through studies of elementary particle processes are discussed. (J.W.R.)

37321 MUONIC ATOMS. Devons, S.; Duerdoth, I. (Columbia Univ., New York). Advan. Nucl. Phys., 2: 295-423(1969).

Work done in the last few years on muonic atoms is reviewed. Experimental methods, muonic atom energy levels, electromagnetic transitions, the nuclear charge distribution, deformed nuclei, nuclear transitions, and muonic x-ray intensities are all surveyed in detail. (J.W.R.)

37322 EXCITATIONS AS GROUND-STATE VARIATIONAL PARAMETERS. Mihailovic, M. V.; Rosina, M. (Josef Stefan Nuclear Inst., Ljubljana, Yugoslavia. Univ. of Ljubljana, Yugoslavia). Nucl. Phys., A130: 386-400(1969).

The ground-state density matrix can be expressed in terms of transition amplitudes $\langle r|a_a^\dagger a_b|g\rangle$ by the following relation: $\langle g|a_a^\dagger a_c a_b^\dagger a_d|g\rangle = \sum_r \langle g|a_a^\dagger a_c|r\rangle \langle r|a_b^\dagger a_d|g\rangle$. A formalism is derived in which these transition amplitudes are used as ground-state variational parameters. The quadratic form with transition amplitudes as variational parameters keeps the above matrix non-negative definite. This represents one necessary N-representability condition. This condition plus symmetry and trace relations are used to bound the two-body density matrix. (It keeps also the one-body density matrix between 0 and 1.) The trial ground state is also restricted in such a way that already half of the particle-hole excited states exhausts the sum over r. The variational equations have the form of a secular equation similar to that in the random phase approximation. The single-particle energies are, however, introduced as Lagrange multipliers for the trace relations of the density matrix. The one-body density matrix is also determined using variation methods. Additional Lagrange multipliers are introduced to guarantee certain symmetry relations, which are disregarded in the RPA. The obtained ground state is then consistent with excited states having different quantum numbers. The calculation for a simple system with a schematic intershell pairing is compared with the exact solution, the RPA and some other methods. The ground state energies and transition amplitudes are good for the entire range of the interaction. (auth)

37323 REACTION MATRIX CALCULATIONS IN FINITE NUCLEI. McCarthy, R. J. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Phys., A130: 305-21(1969).

The binding energy of ^{16}O is calculated using reaction matrix elements obtained from the Hamada–Johnston potential. Reaction matrix elements are defined in terms of a modified harmonic-oscillator spectrum for intermediate states and are calculated using the matrix inversion technique of Köhler and McCarthy. This approach is shown to be very simple and accurate and also very versatile as it allows one to define the low-lying intermediate state spectrum independently from the rest of the spectrum. The dependence of individual matrix elements and total binding energy on the input spectrum is studied in detail. Qualitative arguments are presented to help in choosing a reasonable intermediate-state spectrum to use in first-order Brueckner calculations. However, much work remains before this problem can be completely settled. (auth)

37324 PROJECTED HARTREE–FOCK SPECTRA IN THE p-SHELL. Gunye, M. R.; Law, J.; Bhaduri, R. K. (McMaster Univ., Hamilton, Ont.). Nucl. Phys., A132: 225-33(1969).

The effective forces derived by Shakin et al. (the S-force) from the NN Yale potential, and by Elliott et al. (the E-force) directly from the NN phase shifts are used in Hartree–Fock (HF) calculations for ^7Li, ^8Be, and ^9Be. The forces are found to underbind these nuclei appreciably. The projected HF spectra for these nuclei are slightly compressed compared to the experimental spectra. In the case of the S-force, the $\frac{3}{2}^-$, $\frac{1}{2}^-$ levels in ^7Li come out almost degenerate, while for the E-force, this splitting is right. If the $^3S_1$ matrix elements of both forces are increased by over 30%, the experimental binding energies for these nuclei can be reproduced. The effect of this increase is to spread out the projected spectra. For the S-force, the spread is too large, and an inversion of the $\frac{3}{2}^-$, $\frac{1}{2}^-$ levels in ^7Li also occurs. For the E-force, the spread is such that it produces better agreement with the experimental levels. Finally, the $\frac{3}{2}^-$, $\frac{1}{2}^-$ level ordering in ^7Li can be reproduced using the S-force if a one-body spin-orbit force is arbitrarily added to the HF Hamiltonian. (auth)

37325 TWO- AND THREE-BODY BOUND STATE RESULTS FOR THE TAMAGAKI NUCLEON–NUCLEON POTENTIAL. Pask, Colin (Duke Univ., Durham, N. C.). Nucl. Phys., A132: 234-40(1969).

A potential obtained by Tamagaki enables the two-body scattering data to be fitted reasonably well. The predictions of that potential for the two- and three-body bound-state properties are examined. The results are also compared with those obtained using the Hamada–Johnston potential. (auth)

37326 DISPERSION RELATION FOR THE EQUIVALENT LOCAL OPTICAL-MODEL POTENTIAL. Ahmad, I.; Khan, M. Z. Rahman (Aligarh Muslim Univ., India). Nucl. Phys., A132: 213-20(1969).

Feshbach's dispersion relation for the generalized optical potential is used to obtain, in an approximate way, a dispersion relation for the equivalent local optical-model potential. The dispersion relation is found to be fairly applicable to the phenomenological local potential. The applicability of the Kramers–Kronig dispersion relation to the nuclear case is considered, and it is found to be inappropriate. (auth)

37327 A QUANTITATIVE TEST OF MICROSCOPIC WAVE FUNCTIONS BY THE ANTISYMMETRIZED DWBA. Schaeffer, Richard (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys., A132: 186-94(1969).

Exchange effects in (p, p') scattering are found to yield very large and strongly energy-dependent renormalizations of the cross section. The antisymmetrized DWBA using a free low-energy nucleon–nucleon force and no adjustable parameter gives a test of microscopic models similar to the electron-scattering analysis or the impulse approximation for the lowest 3^- and 5^- states of ^{40}Ca. The experimental magnitude of the cross sections is correctly obtained at three different energies (20.3, 30 and 55 MeV) when using RPA wave functions. (auth)

37328 SHELL-MODEL CALCULATIONS OF ^{42}Ca AND ^{43}Ca USING THE TABAKIN INTERACTION. Clement, David M. (Univ. of California, Davis). Nucl. Phys., A132: 49-59(1969).

An effective interaction for use in the calcium isotopes is derived from the Tabakin interaction. The matrix elements of the effective interaction compare extremely well with those of the Hamada–Johnston force calculated by Kuo and Brown. Comparisons are also made with the Federman–Talmi parameters and the Engeland–Osnes parameters. Shell-model calculations of ^{42}Ca and ^{43}Ca are performed. It is found that the effective interaction which reproduces the ^{42}Ca spectra quite well gives a ground state which is too low in ^{43}Ca. (auth)

37329 A DISCUSSION OF THE SECONDARY-MINIMUM HYPOTHESIS FOR SPONTANEOUSLY FISSIONING ISOMERS. Nix, James Rayford; Walker, George E. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A132: 60-74(1969).

On the basis of the usual assumption of a secondary minimum in a one-dimensional potential barrier, a relationship is derived between the half-life of a spontaneously fissioning isomer, its excitation energy, the fission-barrier height, and the half-life for ground-state spontaneous fission. For ^{241}Am, there is no inconsistency between the experimental values for these four quantities, but the computed half-life for the ground-state spontaneous fission of ^{242}Am is considerably larger than the measured value. On the basis of this discrepancy, the possibility is discussed that the potential-energy surface may be more complicated than previously supposed and contain both a high thin barrier through which ground-state spontaneous fission proceeds and a thicker two-peaked barrier in which the isomer is located and through which induced fission proceeds. Such a two-dimensional potential-energy surface is consistent with both the isomer data and the recently observed intermediate structure in fission cross sections. To help decide whether such a potential-energy surface is indeed responsible for the observed discrepancy for ^{242}Am, it is suggested that for large deformations near the symmetrical saddle-point shapes the nuclear potential energy be calculated as a function of reflection-asymmetrical "P_3-like" deformations. (auth)

37330 ON THE NON-RELATIVISTIC ELECTROMAGNETIC MULTIPOLE–MULTIPOLE INTERACTION BETWEEN TWO DISJOINT CHARGE DISTRIBUTIONS. Alder, Kurt (Univ. of Basel); Winther, Aage. Nucl. Phys., A132: 1-4(1969).

For reference purposes, an explicit and convenient formula for the nonrelativistic electromagnetic interaction between two extended charge-current distributions is given in terms of the electric and magnetic multipole moments of the two systems. (auth)

37331 THE BLOCH L-OPERATOR. Robson, B. A. (Australian National Univ., Canberra). Nucl. Phys., A132: 5-8(1969).

The Bloch L-operator is derived by the rigorous formal method of Mikusinski from simple assumptions concerning the expansion of wave functions and their derivatives in terms of a complete set of orthonormal continuous functions and their derivatives defined within an internal region. (auth)

37332 DISTRIBUTION OF NUCLEAR CHARGE IN HIGH-ENERGY FISSION. Notea, A. (Israel Inst. of Tech., Haifa). Trans. Amer. Nucl. Soc., 12: 286-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37333 THREEFOLD ANALYSIS OF LOW-ENERGY NEUTRON CROSS SECTIONS WITH THE MULTILEVEL EXPANSION. Adler, D. B.; Adler, F. T. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 12: 287-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37334 USE OF THE COMPLEX PARTIAL WIDTHS OF THE KAPUR-PEIERLS FORMALISM IN CROSS-SECTION ANALYSIS AND APPROXIMATE DERIVATION OF R-MATRIX PARAMETERS. Adler, D. B.; Adler, F. T. (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 12: 287(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37335 NUCLEAR MODEL FOR DATA GENERATION AND ANALYSIS IN LIGHT NUCLEI. Yost, K. J. (Oak Ridge National Lab., Tenn.); Pitkanen, P. H.; Fu, C. Y. Trans. Amer. Nucl. Soc., 12: 385-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37336 SYSTEMS APPROACH TO THE NUCLEAR SHELL MODEL. Cohen, Stanley (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 147(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37337 NUCLEAR MODELS AND REACTION CROSS SECTIONS. Vogt, E. W. (Univ. of British Columbia, Vancouver). Trans. Amer. Nucl. Soc., 12: 202(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37338 NUCLEAR MODELS AND NUCLEAR FISSION. Wilets, Lawrence (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 12: 202(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37339 DIRECT-REACTION STUDIES OF NUCLEAR INELASTIC SCATTERING AND CHARGE EXCHANGE. Madsen, V. A. (Univ. of Oregon, Eugene). Trans. Amer. Nucl. Soc., 12: 202(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37340 DIFFRACTION-MODEL ANALYSIS OF DEUTERON AND ^{3}He SCATTERING. Simbel, M. H. (Cairo Univ.). Abul-Magd, A. Y. Nuovo Cim., 61B: 303-16(June 11, 1969).

Diffraction-model analyses are reported for the elastic scattering of deuterons and ^{3}He particles from different nuclei. Inopin–Ericson theory is used, which satisfactorily approximates the exact scattering amplitude at intermediate and large scattering angles and takes account of the smoothness of the surface thickness and the effect of Coulomb and real nuclear phase shifts. The agreement between the theory and experiment is good in most of the cases. The spin–orbit effects are discussed and shown to be small for the cases considered. (auth)

37341 ON THE REACTION MECHANISM IN HEAVY-ION NEUTRON TUNNELLING PROCESSES. Taffara, L. (Univ., Lecce, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy); Vanzani, V. Nuovo Cim., 61B: 365-88(June 11, 1969).

Feynman-diagram techniques are applied to the heavy-ion neutron transfer reactions at energies below the Coulomb barrier. A triangular-graph mechanism is proposed in order to describe the three-body rearrangement process. The effects of the off-energy-shell core–core Coulomb scattering and the initial- and final-state interactions are investigated and compared with those treated in the TMA and DWBA approaches. (auth)

37342 MULTILEVEL STRUCTURES IN A SURFACE COUPLING MODEL. Pascolini, A.; Pisent, G.; Zardi, F. (Univ. Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 61B: 462-81(June 11, 1969).

A surface coupling model, able to generate intermediate structures in the nucleon–nucleus scattering, is dealt with. Particular emphasis is given to the case of several interfering resonances, with the aim of reconsidering, on the grounds of a physical model, the R- and S-matrix approach to the problem. In the case of two interfering levels, the pole collision has been investigated by variation of some meaningful parameters of the model. Some examples of actual cross-section analyses are finally given. (auth)

37343 RECOIL DAMPING IN HEAVY-ION TRANSFER REACTIONS. Dodd, L. R.; Greider, K. R. (Univ. of California, Davis). Phys. Rev., 180: 1187-96(Apr. 20, 1969).

An earlier suggestion by the authors that the unexpected features of angular distributions in heavy-ion transfer reactions at energies above the Coulomb barrier may be explained by including recoil and finite-range effects in a direct-reaction theory, is examined in detail. It is shown that the finite mass of the transferred particle may be taken into account approximately by the inclusion of a recoil phase factor in the transfer function of the usual distorted-wave Born amplitude. The implications of modifying the transfer function are worked out with the help of a sharp-cutoff diffraction model for the scattering of the strongly absorbing nuclear cores. Simple, closed expressions for the transfer differential cross sections are obtained. Unlike the earlier work, these expressions are valid for arbitrary angular momentum transfers, and intrinsic spins are included. When the zero-range limit is used or the mass of the transferred particle is neglected, the model predicts extreme diffraction oscillations in the angular distributions. However, if finite-range and recoil terms are retained, then, at sufficiently high energies and large angular momentum transfers, the theory gives strong damping of the diffraction oscillations. The resulting structureless angular distributions fall off with a $1/q^3$

dependence on the linear momentum transfer q, in excellent agreement with experiment. The theory is applied to the recent experimental results of Birnbaum, Overley, and Bromley for the ^{12}C (^{14}N,^{13}N)^{13}C reaction. Substantial damping of the angular distributions is predicted. (auth)

37344 MICROSCOPIC THEORY OF ROTATIONAL EXCITATION OF NUCLEI. Rogozinski, S. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 35: 783-98(May 1969). (In Russian).

Equations of motion were developed for one-particle amplitudes in a pairing and quadrupole-quadrupole model of residual interactions between one type of fermions in one shell. Equations were obtained for excitation energy, well depth, and elements of the quadrupole moments of even-A nuclei in second-order perturbation theory which are a good approximation of deformed nuclei. For odd-A nuclei, rotational excitation energies differed from the energies obtained with a cranking model. (tr-auth)

37345 DIFFRACTION SCATTERING AND REGGE-POLE TECHNIQUE. El-Wakil, S. A.; Kresnin, A. A. (Atomic Energy Establishment, Cairo). Ann. Phys. (Leipzig), 21: 113-21(1968).

The diffraction scattering of spin-zero nuclei was considered in Regge pole representation. The second pair of poles in the complex l-plane was found to affect the small-angle scattering. This can be shown in the analysis of α-particle scattering on the nuclei ^{24}Mg, ^{64}Zn, and ^{88}Sr. The scattering of two identical particles was also considered at an energy above the Coulomb barrier. Satisfactory results were obtained. (auth)

37346 ANALYSIS OF A METHOD OF SOLUTION OF THE PROBLEM OF TWO-BODY INTERACTION IN A COMMON HARMONIC-OSCILLATOR POTENTIAL WITH HARD CORE. Nigam, B. P. (Arizona State Univ., Tempe). Phys. Rev., 180: 948-52(Apr. 20, 1969).

In an earlier paper, a method was given for solving the problem of two particles in a common harmonic-oscillator potential modified by an effective two-body potential which includes hard-core, central, spin-orbit, and tensor parts. Using the appropriate Green's function, the wave function was expressible in terms of the harmonic-oscillator wave functions, and energy eigenvalues were obtained. The accuracy and convergence of the method is tested by applying it to an exactly solvable (without hard core) case and a partially solvable (with hard core) case, with the intention of applying the method to realistic two-body potentials and calculation of nuclear wave functions and form factors. (auth)

37347 PENETRATION OF A DOUBLE BARRIER. Wong, C. Y. (Univ. of Copenhagen. Oak Ridge National Lab., Tenn.); Bang, J. Phys. Lett., 29B: 143-6(Apr. 28, 1969).

The Hill-Wheeler penetration formula is generalized to the cases where the potential takes the form of (1) two inverted parabolas joined together and (2) a parabola joined at each end by two inverted parabolas. The implications on the determination of fission barriers are discussed. (auth)

37348 EVEN-ODD DIFFERENCES AND STRUCTURE OF THE FISSION BARRIERS. Ignatyuk, A. V.; Smirenkin, G. N. (Inst. of Physics and Energetics, Obninsk, USSR). Phys. Lett., 29B: 159-61(Apr. 28, 1969).

The possibility of the interpretation of the data on even and odd differences of the fission barriers from the point of view of the double-acting fission picture is shown. (auth)

37349 ON THE PHENOMENOLOGICAL THEORY OF THE COLLECTIVE NUCLEAR EXCITATIONS. Rabotnov, N. S.; Seregin, N. S. (Inst. of Physics and Energetics, Obninsk, USSR). Phys. Lett., 29B: 162-4(Apr. 28, 1969).

The collective phenomenological potential dependent on two variables β,γ is discussed and chosen. The resulting Schrödinger equation with 5 dynamical variables (including Euler angles) is solved numerically and results compared with experimental data on energy levels of even-even nuclei. (auth)

37350 EXTENSION OF THE GENERALIZED SENIORITY COUPLING SCHEME. Lorazo, B. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., 29B: 150-4(Apr. 28, 1969).

The total configuration space of the shell model for N particles can be broken into several subspaces which differ between themselves by the number of particles being in a pair state. The projection of the exact shell model wave functions onto these subspaces is studied as well as the result of diagonalizing the interaction within each subspace separately. The case of $J = 0^+$ states is studied for a pairing force and a surface delta interaction in the case of ^{62}Ni and ^{116}Sn and also for more realistic interactions in the case of ^{62}Ni. (auth)

37351 DELAYED NUCLEAR FISSION. Berlovich, E. E.; Novikov, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 29B: 155-6(Apr. 28, 1969).

A possibility of occurrence of delayed nuclear fission is shown. Boundaries of nucleon stability (nuclear regions where this phenomenon can be observed) are estimated. Neutron-rich nuclei which can form effectively in the rapid neutron capture process constitute a large region of delayed fission, and that is why the phenomenon under study is of some interest not only for nuclear physics, but also for astrophysics. (auth)

37352 QUASI-FREE SCATTERING OF NUCLEONS BY NUCLEI. Sarma, N. (Bhabha Atomic Research Centre, Trombay, India). Proc. Nucl. Phys. Solid State Phys. Symp., 1968, Bombay, 19-40(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.1).

The quasi-free scattering of nucleons is reviewed from an experimental and a theoretical viewpoint. The methods of investigation and some of the results obtained are discussed. The importance of these measurements for the investigation of the inner shells in nuclei is shown. The cross section for the reaction in the DWIA and DWBA is derived theoretically and the approximations made are exposed. Some features of the cluster knockout process and the areas of future development in theory and experiment are indicated. (auth)

37353 SUM RULE METHODS AND THEIR APPLICATIONS TO NUCLEAR SPECTROSCOPY. Bansal, R. K. (Punjab Univ., Chandigarh, India). Proc. Nucl. Phys. Solid State Phys. Symp., 1968, Bombay, 41-65(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.1).

Within the framework of shell theory and restricted to the case of single-nucleon-transfer reactions, the general formalism of the multipole sum rule techniques, both for stripping and pick-up reactions is sketched briefly. As special cases of the general approach, the following are discussed. (a) The Non Energy Weighted Sum Rules: these result in the equations relating the spectroscopic factors (for single nucleon transfer) to the multipole moments of the shell-model-target state. (b) The Energy Weighted Sum Rules: these relate the energy-weighted-averages of the spectroscopic factors to the interaction parameters of the shell-model-residual interaction. Applications to the nuclei in and around $f_{7/2}$ region of the periodic table are discussed. (auth)

37354 RECENT WORK AND IMMEDIATE PROSPECTS IN X-RAY AND GAMMA-RAY SCATTERING. Kane, P. P. (Indian Inst. of Technology, Bombay). Proc. Nucl. Phys. Solid State Phys. Symp., 1968, Bombay, 87-106(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.1).

Results pertaining to elastic scattering of gamma rays of MeV energies and published by various authors during the previous year or so are critically examined. The precise relationship between nuclear Thomson scattering and scattering involving the variation of internal nuclear co-ordinates is clarified in the long wavelength limit. The possibility of dispersive Delbruck scattering amplitudes and questions regarding the relative phases of the various elastic scattering contributions are discussed. Work relevant to the multiple Compton effect and Compton scattering by bound atomic electrons is presented. Theoretical and experimental investigations of the details of line shapes in scattering are considered especially from the standpoint of promising future work. Results obtained on the scattering of 1.12- and 1.33-MeV gamma rays through 90° and 124.5° by different elements are reported. The significance of these results is pointed out. (auth)

37355 SUM AND SUM-PEAK COINCIDENCE SPECTROSCOPY. Lakshminarayana, V. (Andhra Univ., Waltair, India). Proc. Nucl. Phys. Solid State Phys. Symp., 1968, Bombay, 107-23(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.1).

Sum and sum-peak coincidence spectroscopic techniques are ideally suited for investigations on cascade modes of decay and angular correlations. Sum-peak coincidence studies yield useful information on cascade-crossover ratios. The principles of these techniques are outlined and their shortcomings will be discussed. The applications of these techniques are illustrated by a few typical examples and the results are discussed. (auth)

37356 SHELL EFFECTS IN POTENTIAL RADII DEDUCED FROM (d,^{3}He) ANGULAR DISTRIBUTIONS. Kaschl, G. Th. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Wagner,

G. J.; Mairle, G.; Schmidt-Rohr, U.; Turek, P. Phys. Lett., 29B: 167-9(Apr. 28, 1969).

Systematic phase displacements between measured (d,^{3}He) angular distributions and conventional DWBA calculations are observed. They can be removed by shell-dependent optical parameters. The j-effect on l = 2 angular distributions is interpreted as a shell effect. Arguments are given that there are some geometrical shell structure nuclei. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 36096 and 37448.

37357 (AECL-3258) GENTILLY BLW BOOSTER ROD EXPERIMENTS IN THE ZED-2 REACTOR. Roshd, M. H. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb. 1969. 45p. Dep. CFSTI. CAN $1.00.

Measurements were performed in ZED-2 on simulated BLW 61-element boosters containing 5, 6.56 and 7.46 g of ^{235}U per cm length. These boosters either replaced the central fuel assembly in a rod centered lattice or were located interstitially in an open center lattice. The perturbing effects of the booster on the neutron density distribution and the epithermal index $r\sqrt{T_n/T_0}$ were investigated. The fine structure and the reactivity worth of each booster were measured in the two lattices. The reactivity of the 5 g/cm booster was also measured as a function of radial position. (auth)

37358 (AECL-3326) ANNUAL REPORT, 1968-1969. (Atomic Energy of Canada Ltd., Ottawa (Ontario)). 44p. CAN.

An account of the Company's activities for the period April 1, 1968 to March 31, 1969 is given and the financial statement is presented. Some highlights are: plan for Bruce generating station consisting of four 750 MW reactors and an 800 tons (annual) heavy water plant on a site at Douglas Point, Ontario; merger on July 1, 1968 of Canadian General Electric and AECL, Power Projects nuclear power design and engineering teams; formation of a nuclear power export marketing group; conversion of NPD to boiling heavy water operation; Canada-France information exchange and plutonium sales agreement; exchange agreement of technical information with Japan; sales record set for teletherapy units. (F.S.A.)

37359 (CONF-681008-9) APPLICATION OF GAS-COOLED REACTORS TO URBAN SITES. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). [1968]. 7p. (SM-111/44). Dep. CFSTI. UK.

From Symposium on Advanced and High Temperature Gas-Cooled Reactors, Juelich, Germany.

Problem areas in the field of safety standards for power reactors are discussed. Common practices in attempts at evaluation of risk are described; proposals for overcoming variances in risk evaluation are given. Systems which have a direct bearing on the safety of a reactor are summarized by their effect as: the primary circuit, shutdown system, emergency cooling, coolant fission product inventory, and pressure vessel. (M.L.S.)

37360 (CONF-681101-32) PRACTICE AND CONSIDERATIONS OF POWER REACTOR SITING IN GERMANY. Birkhofer, A. (Technische Hochschule, Munich (West Germany)). [1968]. 12p. Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

A brief history of German power reactor siting practices is presented. Effects of engineered safeguards and refined analytical methods on siting policies are considered. Population densities are shown as a function of distance from the reactor for the VAK, Gundremmingen, Lingen, Obrigheim, Wuergassen, Stade, and for the Frankfurt area. Effects of future power demands on urban siting of power reactors are evaluated. (M.L.S.)

37361 (CONF-681101-33) PROBLEMS AND CONSIDERATIONS OF U. S. REACTOR SITING. Case, Edson G. (Division of Reactor Standards (AEC), Washington, D. C.). Nov. 11, 1968. 13p. Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The procedures used by the USAEC for establishing rules and regulations for power reactor licensing are discussed. Effects of population density and land use characteristics on site evaluation are considered; physical characteristics, such as seismology, geology, etc., are described with respect to their role in site evaluation. Effects of reactor design and proposed reactor operation on the physical location of the reactor are discussed. (M.L.S.)

37362 (CONF-681101-34) POWER REACTOR SITING IN CANADA. Laurence, G. C. (Atomic Energy Control Board, Ottawa (Ontario)). [1968]. 11p. Dep. CFSTI. CAN.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The basic philosophy for evaluation of Canadian power reactor safety is discussed. The basic principles applied to design evaluation are listed. These principles are categorized according to whether they apply to the reactor design or to the site for the reactor. The basic philosophy is then evaluated. (M.L.S.)

37363 (CONF-681101-36) ASPECTS ON THE POWER REACTOR SITING PROBLEM OF VAERTAN REACTOR IN STOCKHOLM, SWEDEN. Ryman, Jan-Erik. [1968]. 11p. Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

A description is given of the Vaertan Power Reactor, which is proposed for underground siting in downtown Stockholm, Sweden, to produce steam heat for the heart of the city and electricity for the grid. Safety aspects are described. The economics and utility of the plant are considered. Heat and power requirements for the Stockholm area are estimated. A cutaway shows the underground location of the reactor and associated buildings. (M.L.S.)

37364 (CONF-681101-37) TREATMENT GIVEN TO SOME SPECIFIC TECHNICAL PROBLEMS IN SAFETY REVIEWS IN EUROPE. Vinck, W.; Maurer, H. (European Communities, Brussels (Belgium). Commission); Karwat, H. (Technische Hochschule, Munich (West Germany). Institut fuer Mess- und Regelungstechnik). Nov. 4, 1968. 64p. Dep.

From International Conference on the Constructive uses of Atomic Energy, Washington, D. C.

Specific technical questions arising during safety analyses of light water cooled power reactor projects in the EURATOM community are discussed. Problems related to postulated primary system blowdown are analyzed; methods used to treat the problems are outlined. Control rod drop and control rod ejection analyses are discussed; analytical procedures used for quantitative evaluation are outlined. Evaluation of fatigue effects on the pressure vessel and intervals is considered. Methods of reliability assessment used in the safety analyses are detailed. 13 references. (M.L.S.)

37365 (CONF-681129-1) PAPER FOR CHAIRMAN OF AIF PANEL ON REACTOR SAFETY LICENSING, CODES AND STANDARDS. Cave, L. [1967]. 5p. Dep.

From Atomic Industrial Forum Conference, Washington, D. C.

The legal framework and siting policies for power reactors in the United Kingdom are reviewed from the industry point-of-view. Population distributions for England are discussed. The role of the prestressed concrete pressure vessel and integrated coolant circuits in increasing the safety of the power reactor is discussed. Population distributions for the Heysham and Hartlepool sites are tabulated for 0-2 miles, 2-5 miles, and 5-10 miles. The designer's use of probability analysis for assessment of safety of the reactor is described. 8 references. (M.L.S.)

37366 (CONF-690609-8) SUBCOOLED-BLOWDOWN: LOFT-QUARTER-SCALE EXPERIMENTAL PRESSURES AND CALCULATED TRANSIENTS USING THE WHAM-CODE. Hanson, George H. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 18, 1969. Contract AT(10-1)-205. 24p. Dep. CFSTI.

Experimental measurements of effects of subcooled blowdown on power reactor cooling systems are described; the results of these experiments are compared with the WHAM code to check its validity in calculating transients and blowdown effects. The use of WHAM-calculated blowdown pressures as forcing function input for structural dynamics codes is discussed. (M.L.S.)

37367 (DOCKET-50029-2) YANKEE NUCLEAR POWER STATION. Final Hazards Summary Report, Vols. 1 and 2. (Yankee Atomic Electric Co., Boston, Mass.). [1959]. 923p. Dep. CFSTI.

YANKEE POWER REACTOR—core for, preliminary safety analysis of design for
—cooling system for, preliminary safety analysis of design for
—emergency and auxiliary systems for, preliminary safety analysis of
—control systems and instrumentation for, preliminary safety analysis of
—steam and power conversion systems for, preliminary safety analysis of
—radiation protection and waste disposal at, preliminary safety analysis of
—engineered safeguards for, preliminary safety analysis of
—electrical system for, preliminary safety analysis of
—containment systems for, preliminary safety analysis of

—site for, preliminary safety analysis of
—operation of, preliminary safety analysis of proposed
—safety evaluation of, preliminary (M.L.S.)

37368 (DOCKET-50321-11) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 7. (Georgia Power Co., Atlanta). June 24, 1969. 41p. Dep. CFSTI.

Design of rod block monitor system for the Edwin I. Hatch Power Reactor, Unit 1 is discussed. The design and functioning of the auto relief interlock are described. The flow reference scram is discussed; scram reliability is evaluated. Design of the Emergency Core Cooling Systems (ECCS) suction piping is discussed; schematics are included. (M.L.S.)

37369 (DOCKET-50323-6) NUCLEAR PLANT, DIABLO CANYON SITE, UNIT 2. [Preliminary Safety Analysis Report], Amendment 3. (Pacific Gas and Electric Co., San Francisco, Calif.). June 23, 1969. 339p. Dep. CFSTI.

The containment ventilation system for the Diablo Canyon Power Reactor, Unit 2 is described. Reactor trip circuits are tabulated; modifications are indicated; each of the trip modes is discussed. The interaction between control and protection instrumentation systems is analysed. The power supply for the part-length control rod drives is detailed. Actuation instrumentation for the engineered safety features is described; the information is summarized in tabular form. Operation of engineered safeguards instrumentation in a post-accident environment is considered. The remotely-operable miniature neutron flux monitors for in-core use are described. The efficiency of the fuel handling building ventilation system is assessed. The fuel handling accident is analyzed; additional information is given on other Final Safety Analysis Report (FSAR) safety analyses. A blowdown analysis for large and intermediate coolant loop breaks is included. Results of containment pressure transients are evaluated. Maximum estimated off-site doses from hypothetical accidents are tabulated. Quantities of radioactive isotopes present in the core, fuel rod gap, and recirculated sump water are calculated; data are tabulated. A detailed analysis of the accumulation and control of hydrogen in the containment system following a coolant loss accident is included. (M.L.S.)

37370 (DOCKET-50327-5) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 2. (Tennessee Valley Authority, [Knoxville]). May 28, 1969. 227p. (DOCKET-50328-5). Dep. CFSTI.

The compliance of the engineered safety features for Sequoyah Power Reactor, Units 1 and 2 with the general design criteria is assessed. Design and operation of the engineered safeguards are detailed. The evaluation of design changes with respect to meeting single active or passive failure criteria is given. Response of the Emergency Core Cooling Systems (ECCS) to reflood the core in the event of a coolant loss accident is evaluated. Design parameters are tabulated for the accumulator, boron injection tank, refueling water tank, and ECCS pumps. Results of single active failure analyses of the ECCS are listed. Bus assignments to the emergency power system are specified for ECCS components. Control and functioning of the cooling system charging pumps are described. The gas stripper-boric acid evaporator packages are discussed. Design data for the principal components of the chemical and volume control system and the residual heat removal system are tabulated. Blowdown analyses for primary system pipe ruptures are detailed; data are tabulated and shown graphically. (M.L.S.)

37371 (DOCKET-50329-5) [MIDLAND PLANT, UNITS 1 AND 2]. Preliminary Safety Analysis Report, Amendment 2. (Consumers Power Co., Jackson, Mich.). June 5, 1969. 196p. (DOCKET-50330-5). Dep. CFSTI.

Additional or revised details on the site for the Midland Power Reactor, Units 1 and 2 are given; information on soils and foundation investigations and on climatology is detailed; data are presented in tabular form. Emergency plans for the Midland plant, the Dow chemical plant, and the Dow Corning plant are discussed. Design, manufacture, and testing of pressure vessels for the Midland Reactors are detailed. Details on the prestressing tendons and reinforcing steel are given. The methods used for assuring leak-tightness of the containment building penetrations are described. The design and operation of the reactor building spray system are discussed. Environmental effects of an assumed coolant loss accident are analyzed; data are shown graphically. (M.L.S.)

37372 (DOCKET-50333-5) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. [Preliminary Safety Analysis Report], Amendment 2, Suppl. 1. (Power Authority of the State of New York). June 20, 1969. 94p. Dep. CFSTI.

Details of geologic investigations of the James A. Fitzpatrick Power Reactor site are given. Geologic age and stress measurements are described; formation mechanisms are discussed. Revised or additional pages are included for several sections of the original SAR. (M.L.S.)

37373 (DOCKET-50334-6) BEAVER VALLEY POWER STATION. [Preliminary Safety Analysis Report], Amendment 3. (Duquesne Light Co., Pittsburgh, Pa.). Apr. 23, 1969. 314p. Dep. CFSTI.

Revised information on design criteria and loadings for the Beaver Valley Power Reactor containment structure is given. Containment construction is discussed. Details on the design and operation of the Emergency Core Cooling Systems are given; other engineered safety features are described. The component cooling system is discussed. (M.L.S.)

37374 (DUN-SA-96) N REACTOR-WPPSS COMPLEX: OPERATING PERFORMANCE. Leitz, Emil E. (Douglas United Nuclear, Inc., Richland, Wash.). [1969]. Contract AT(45-1)-1857. 19p. (CONF-690609-23). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

A brief review of the significant accomplishments of the N Reactor-WPPSS complex is provided. Significant operating experience also has been obtained at N Reactor. Brief descriptions of the achievements and some of the accompanying operating problems which have been encountered are presented. (auth)

37375 (DUN-SA-117) FIRE-RESISTANT HYDRAULIC FLUIDS FOR REACTOR SAFETY SYSTEMS. Gerrard, J. M. (Douglas United Nuclear, Inc., Richland, Wash.). May 28, 1969. 7p. (CONF-690609-21). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

The fire resistant hydraulic fluids for the Hanford N Reactor control rod drive systems are discussed. Safety rod system operating conditions are described; requirements of the hydraulic fluid are detailed. Use of the water-oil invert emulsion is summarized; compatibility with rod drive systems components is discussed. Flammability and viscosity of the invert emulsion are described. (M.L.S.)

37376 (EUR-4220) REPERCUSSION OF THE CONSTRUCTION OF PUMPED STORAGE STATIONS ON THE ECONOMIC SITUATION OF NUCLEAR POWER PLANTS. Final Report. (Electrobel, Brussels (Belgium). Societe Belge d'Economie et de Mathematique Appliquees, S. A., Brussels). Nov. 13, 1968. Contract 027-66-4-ECIB. 178p. Dep.

Advances in nuclear engineering now enable constructors to offer electrical generating plants at a very low proportional cost (about 2 mills/kWh). However, this low cost is attained only with very large plants (600 MW). This situation greatly favors pumped storage stations, which can supply the grid with peak power at a cost not exceeding that of the power required for pumping divided by the efficiency (about 70%). In addition the great flexibility of operation of the pumped storage station enables it to play a useful part in regulating the load on the machines and in covering the reserve. However, the decision to integrate a pumped storage station in a production network will depend largely upon the investment necessary to equip a site. The resultant optimum utilization of the baseload groups makes it possible to increase the proportion of nuclear plants which it is economic to install. This increase, in additional installed nuclear MW, corresponds approximately to the mean pumping during the off-peak night periods. 21 references. (auth) (EURATOM)

37377 (EUR-4221) LATINA NUCLEAR POWER PLANT. Annual Report, 1967. (Ente Nazionale per l'Energia Elettrica, Latina (Italy)). 1969. Contract 002-61-12-REPI. 48p. (In Italian). Dep.

In the fourth operating year of the Latina power plant the highest availability and utilization factors since start-up were reached (86.65 and 86.20% respectively). The outages were attributable principally to the conventional parts of the plant. The incidence of load reductions required by the distributor (0.45%) confirms the good utilization of the plant as a base load plant. There were no major shutdowns except during 1–10 April, when a scheduled general overhaul of the main turbines, auxiliaries and exchangers was carried out. As regards fuel behavior, an increase in can bursts was noted in certain channels, probably owing to the thermal transient described in the 1966 Annual Report. On the other hand, in the core zone with maximum dwell-time the five years residence was exceeded and in some channels the burnup reached values close to 3000 MWd/t without trouble. Detailed information is presented on the main activities of the Health Physics Department, and in particular in monitoring of the activity and contami-

nation levels within and outside the plant, the special decontamination work, and the doses received by the staff. The plant chemistry reported deals with the behavior of the gas residues in the primary coolant, the treatment of active effluents, the conditioning of the steam generators, the treatment of the condensers, and the demineralization plant. (auth) (EURATOM)

37378 (GA–8795) THE FORT ST. VRAIN PRESTRESSED CONCRETE REACTOR VESSEL. Buttemer, D. R.; Rockenhauser, W. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 1, 1968. Contract AT(04-3)-633. 14p. (CONF-681209-3). Dep. CFSTI.

From Winter Annual Meeting of the American Society of Mechanical Engineers, New York.

The Fort St. Vrain nuclear generating station, to be located approximately 35 miles north of Denver, Colorado, will be the first station in the United States to use a prestressed concrete reactor vessel. The structural action and design details of the prestressed concrete reactor vessel are described in this paper. (auth)

37379 (NP–17851) ARTICLES ON PROBLEMS OF NUCLEAR PROTECTION. (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). 1967. 216p. (In Hungarian). Dep.

Information on problems of reactor safety and application of atomic energy is included under the following headings: safety problems in nuclear power plants; review of reactor accidents; safety problems in reactor control; safety evaluation of reactor sites; operational safety of nuclear power plants; radiation protection; administrative problems with reactor safety; and international and national instructions, agreements, and standards. Separate abstracts are included for each of the 8 sections presented. (D.C.C.)

For abstracts of individual sections see: 37380–37383, and 37558–37561.

37380 (NP–17851, pp 7-14) GENERAL SURVEY OF THE SAFETY PROBLEMS OF NUCLEAR POWER PLANTS. Nyerges, Pal (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In Hungarian).

The special features of reactor power plants make it necessary to provide protection for the environment and for the population at large. The Atomtechnical Section of the Scientific Society for Energy Economics established a working committee to review the hazards resulting from the operation of nuclear power plants and to identify the pertinent rules, standards and regulations. The goals of the reactor safety program are: to ensure the safe operation of the reactor plant; to protect the personnel; and to protect the population from injury resulting from explosion, shock wave or the massive release of radioactive fission products. The term "reactor safety" refers to third persons, while "reactor protection" steps refer to measures aimed at the accident-free operation of the reactor itself and protection of its personnel. The three barriers between the radioactivity within the system and the external world are: the fuel matrix and its cladding; the boundary of the primary system, and the reactor containment vessel. The study will serve as the starting point for organizing reactor safety measures at the proposed Hungarian nuclear power plant. (TTT)

37381 (NP–17851, pp 73-100) SAFETY EVALUATION OF REACTOR SITES. Hejj, Attila (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In Hungarian).

Selection of a reactor site is influenced by economic, political, social, cultural and safety considerations. The latter include population density, distance from large cities, meteorological considerations, hydrological situation (level of the groundwater), the probability of earthquakes, and general topography. The basic assumption is that the risk to the population is decreased by increasing the distance between the nuclear power plant and large population centers. This raises problems in densely populated countries and affects the economic considerations because the power plant may be placed too far from its potential industrial consumers. The direction and velocity of prevailing winds must be taken into account; the tendency toward inversion in the chosen region is undesirable, but a strong upward flow of the air assists in the dilution and prevents the creation of inversion layers. Deep valleys are unsuited because they facilitate the accumulation of contaminated materials. For the same reason, open meadows and flat areas are to be preferred over rolling wooded areas. Operational experience of nuclear power plants indicated that no undue concentration of radioactive materials in the air, water, and the ground above background level results from the regular operation. The safety principles applied in the USSR, USA, Great Britain and some other countries are examined. There is definite tendency toward reducing the strict requirements of great distance of the reactor plants from large cities. (TTT)

37382 (NP–17851, pp 101-26) OPERATIONAL SAFETY OF ATOMIC POWER PLANTS. Bede, Gabor (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In Hungarian).

The operational safety of a nuclear power plant may be examined from the viewpoint of health physics or electrical energy generation. The design must take into consideration the maximum credible accident. In pressurized water systems, reactivity and coolant loss accidents are used as basis for safety studies. The accident prevention measures are often based on architectural or design solutions, such as providing for multiple closures, flooding of the reactor building, etc. Provisions must be also made for dissolution of the radioactive wastes, emergency cooling, etc. No single step ensures the overall safe operation of the whole system. Engineered safeguards are necessary. The correct operation of the plant is very important; detailed instructions must be developed for all routine and foreseeable emergency operations. Safety in electric energy generation requires that the plant satisfy the needs of its customers under all conditions; potential sources of breakdown must be analyzed and eliminated. The designer must evaluate the problems associated with the core, the primary circuit, transient behavior, heat flux, etc., in order to calculate the containment vessel and the shield. Prevention of coolant leakage is very important. The secondary system usually follows the safeguards used in conventional power plants, although they should be applied more strictly. Preventive maintenance must be practiced to avoid breakdowns. (TTT)

37383 (NP–17851, pp 163-76) ADMINISTRATIVE PROBLEMS FROM THE VIEWPOINT OF SAFETY. Bede, Gabor (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In Hungarian).

The current personnel practice in nuclear power plants is to hire the same type of personnel as for fossil plants, although it is expected that the workers have the educational background to learn the needed nuclear material during on-the-job training. Courses are often started several years before startup of the plant to ensure the availability of qualified personnel. It is desirable to have the future operating personnel on the site during construction to enable them to learn the technical details of the plant and to make minor technical repairs. Radiation protection must be organized as a separate service group. A large research center often cooperates with the power plant and assumes the responsibility for applied health physics operations. Special zones must be established throughout the plant, designating each room as an uncontrolled area where individuals may stay as long as they want to, or as a specified controlled zone. The first zone has no neutron flux and a γ flux of less than 2.5 mR/hr. The permissible dose rates and times of occupancy must be clearly stated for all zones. The administrative rules must make provisions for operation under emergency conditions and in case of accidents. A designated engineer must be in absolute charge of the plant, in order to avoid issuance of contradictory orders. Plans must be prepared for the orderly evacuation of the buildings and for decontamination of victims at a nearby location. (TTT)

37384 (NP–17901) SUMMARY OF THE VAERTAN SAFETY FEATURES. (Allmanna Svenska Electriska A. B., Vasteras). Mar. 25, 1969. 5p. Dep.

The safety features of the Vaertan Power Reactor, to be built underground in downtown Stockholm, Sweden, are summarized. The integrity of the primary containment vessel is discussed; secondary and turbine containment is described. The emergency cooling systems and off-gas system decay arrangements are outlined. (M.L.S.)

37385 SMALL AND MEDIUM-SIZE POWER REACTORS. Proceedings of a Panel, Vienna, June 24–28, 1968. Panel Proceedings Series. (International Atomic Energy Agency, Vienna (Austria)). 1969. 181p. (CONF-680652). IAEA: $5.00; Austrian Schillings 130,-; Pound 2.1.8; F Fr 24,50; DM 20,-.

Information concerning the world-wide development of economic 0.5 to 300 MW(e) nuclear power plants is presented. Separate abstracts are included for each of the 16 papers presented. (D.C.C.)

For abstracts of individual papers see: 37401–37415, and 37677.

37386 (TID–25021) SUMMARY OF CURRENT SEISMIC DESIGN PRACTICE FOR NUCLEAR REACTOR FACILITIES. (Blume (John A.) and Associates, Engineers, San Francisco, Calif.). Sept. 1967. Contract W-7405-eng-26. 142p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Procedures currently used in the evaluation of seismic design criteria for analysis of nuclear power plant earthquake resistance are summarized. The methods are illustrated for a BWR, but they are applicable to any type nuclear power plant. Earthquake ground motion criteria are defined; soil-structure interactions

and time-history are analysed. Methods for analysis of containment and pressure vessels are described. Analyses of equipment mounted in the reactor building and piping systems are given. Damping is discussed; methods for arriving at damping factors are described. Hydrodynamics problems encountered in the seismic design of reactor plants are discussed. 33 references. (M.L.S.)

37387 (WAPD-PWR-TE-209) EVALUATION OF REACTOR STEADY STATE THERMAL AND HYDRAULIC TEST PERFORMANCE FOR THE FIRST HALF OF PWR CORE 2, SEED 1 LIFE. Crum, D. L. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1968. Contract AT(11-1)-Gen-14. 168p. Dep. CFSTI.

Results and evaluation of the data obtained from the thermal and hydraulic testing performed on the second core installed at the Shippingport Atomic Power Station from the beginning-of-life to the approximate mid-life of the first seed are presented. The data are compared with both best estimate and design calculations to provide a basis for evaluation of both the core thermal performance and the adequacy of the thermal and hydraulic design procedures. It is concluded that the thermal margin of safety of the core exceeded that indicated by the thermal design analyses at all times and that the hydraulic analysis design procedures and the applicable portions of the nuclear and thermal analysis procedures are generally satisfactory with certain exceptions noted. The core instrumentation was observed to perform satisfactorily and the importance of frequent or timely instrument calibrations was indicated. (auth)

37388 REACTOR COOLANT γ-SPECTRA IN I BLOCK OF NOVO-VORONEZH NUCLEAR POWER STATION. Miller, O. A.; Demidov, A. M.; Ovchinnikov, F. Ya.; Golubev, L. I.; Sunchugashev, M. A. At. Energ. (USSR), 25: 524-6(Dec. 1968). (In Russian).

The γ spectra curves obtained from water coolant samples 3 to 4 hours and 3 days after sampling are presented. Principal fission products identified from the spectra are listed. (R.V.J.)

37389 ATOMIC POWER: WHO LOOKS AFTER PUBLIC SAFETY? Ackerman, Adolph J. IEEE (Inst. Elec. Electron. Eng.), Trans. Aerospace Electron. Syst., AES-5: 363-75(May 1969).

Questions of basic policy and public safety in commercial nuclear power development are reviewed. Responsibility for public safety by industry and government is outlined. How public acceptance of the present program of atomic power development is being influenced is cited. Ethical considerations for engineers concerned with the design and construction of power reactor installations are stated. (BBB)

37390 MARVIKEN HEAVY WATER STEAM TURBINE. Olesen, Carsten B. (Stal-Laval, Sweden). Nucl. Eng. Int., 14: 570-2(July 1969).

The first known turbine intended for operation with heavy water steam is described. Special methods and designs of new components necessary to ensure a high degree of tightness and to adapt the turbine to operation with radioactive steam are discussed. The effect of the high cost of heavy water on the plant layout is described. Special attention was given to radical simplification of the condensing and feed heating plant and special shaft glands. (auth)

37391 STATUS REPORT ON THE DESIGN AND CONSTRUCTION OF THE FORT ST. VRAIN NUCLEAR GENERATING STATION. Walker, R. F. (Public Service Co. of Colorado, Denver). pp 121-31 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The design of the Fort St. Vrain Nuclear Generating Station Unit No. 1, a 330 MW(e) advanced high-temperature gas-cooled reactor, located 35 miles north of Denver, is essentially complete, and preliminary construction was started in April 1968. Extensive research and development and design and engineering work on such advanced features of this project as the prestressed concrete reactor vessel and the high-speed series steam-turbine-driven He circulators, compact once-through steam generators and the graphite core containing the fuel in the form of UC and ThC all contained within the reactor vessel has been performed. Full-scale testing of the He circulator prototypes is continuing and will be followed by proof testing at full-design conditions of the production units prior to their installation at Fort St. Vrain. Additional testing related to the steam generator modules, prestressing tendons and control rod drives is progressing satisfactorily. Additional confirmation of the outstanding characteristics of the coated-fuel particles to be used in this reactor will be obtained from additional fuel capsule irradiations and from the performance of the Fort St. Vrain test element in the 40-MW(e) Peach Bottom Station reactor core. (auth)

37392 THE 25-MW(e) GEESTHACHT KSH NUCLEAR POWER PLANT. Boehm, E.; Ehret, A.; Geppert, H.; Hauck, W.; Klussmann, A. (Gutehoffnungshuette Sterkrade AG, Oberhausen-Sterkrade, Ger.). pp 109-20 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

A 25-MW(e) high-temperature reactor with He turbine in direct cycle is being built at Geesthacht, near Hamburg. The core consists of graphite fuel rods which contain enriched U and Th in the form of coated particles with porous oxide kernels and pyrocarbon and SiC coatings. To achieve a flat power distribution over the 900 days lifetime, zoning of the core was chosen. The control rods are introduced from the bottom of the pressure vessel. The control rod requirement is reduced by accommodating burnable poison in a number of fuel elements. The reactor has a negative temperature coefficient. Full Xe override is possible. The coolant flow in the core is directed upwards. The He enters the turbine through a concentric pipe at 730°C and 25 atm. The turbo set is designed as a single-shaft arrangement with dual-stage intercooling and recuperative heat exchanger. The plant net efficiency is about 37%. The output is controlled by varying the main loop He inventory which results in a practically constant efficiency also at part-load operation. The main loop components and all important auxiliary installations are located in a cubic concrete building. A smaller building houses the control room, the electrical and conventional supply systems and the offices. (auth)

37393 FUEL HANDLING EQUIPMENT FOR DUNGENESS 'B'. Ambrose, M. J. F. (Atomic Power Constructions Ltd., Surrey, Eng.); Jerkins, E. pp 91-207 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

In the AGR on-load fuel handling is made extremely reliable by the well-known principle of single-channel access in which the fuel is part of a single continuous assembly from the bottom of the core to the level of the charge face. Consequently, grabs do not have to enter the reactor space and the fuel can be discharged/charged by a single raising/lowering action from the fueling machine placed immediately above the fuel channel. The principal function of the fueling machine, which is mounted on a gantry spanning both reactor pressure vessels, is to transfer fuel between the reactor and the ancillary processing areas, namely the new fuel storage area and the irradiated fuel handling facility which includes the decay pond. The design of this fuel-handling system has to satisfy certain minimum requirements. Operations over the reactor must be performed without prejudice to the reactor's safety. While operating on-load there must be no damage to fuel elements, either to new fuel entering the reactor or to the irradiated fuel on its way to the pond, since this could lead to release of activity or over-heating. The operation must be performed at a pace which satisfies the needs of the fuel cycle. Contamination control and shielding must be adequate throughout the fuel handling route, and the machinery with its control and monitoring arrangements must be simple enough for its reliability to be ensured. The fuel loading equipment in Dungeness 'B' design is described. (auth)

37394 PROGRESS ON THE ENGINEERING AND CONSTRUCTION OF THE DUNGENESS "B" NUCLEAR POWER STATION. Silk, E. F.; Cameron, R. (Atomic Power Constructions Ltd., Surrey, Eng.). pp 75-89 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

Progress during the first two years or so of the Dungeness "B" construction program is described. Work on this 1200 MW(e) station, incorporating the first commercial Advanced Gas-cooled reactors, started at the beginning of 1966. The first unit is scheduled to be on full load in 1970 and the second in 1971. Some of the unusual measures which have had to be adopted as a result of special features of the site or of the design are discussed. Thus, the features of the site which led to a decision to vibro-compact the sand and build deep rafts to carry the three main buildings, are examined. The advanced structural steelwork design posed some interesting problems during erection and strict rules have had to be followed to ensure stability at all stages. The unorthodox architectural treatment led to wind-tunnel testing of a model to verify the stability of the finished building in high winds. A brief engineering description of the concrete pressure vessel and its prestressing systems follows, together with some aspects of the program of test work connected with this, including model tests on the concrete vessel. The influence of the engineering requirements on the method of construction is then discussed. Progress off-site in such areas as fuel handling, gas circulators, boilers, and other plant is described. 12 references. (auth)

37395 PERFORMANCE OF THE CENTRAL ELECTRICITY GENERATING BOARD NUCLEAR POWER STATIONS. Silverleaf, D. J.; Weeks, R. J. (Central Electricity Generating Board, London). pp 51-73 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The operator's experiences of the nuclear power stations brought into service by the CEGB during the course of the First British Nuclear Power Programme are summarized. The main conclusion is that nuclear power stations, of the type of which the CEGB now has extensive experience, do not present nuclear difficulties, but only the usual engineering difficulties common to so-called conventional stations. Nuclear and conventional costs are compared and the methods employed in nuclear costing are explained. The reduction of commissioning programs to the necessary minimum at the Board's nuclear stations is described. 5 references. (auth)

37396 SIGNIFICANT OPERATING EXPERIENCES OF THE PEACH BOTTOM ATOMIC POWER STATION. Green, R. W. (Gulf General Atomic Inc., San Diego, Calif.); Kemper, J. S. pp 21-36 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The Peach Bottom Atomic Power Station contains the first high-temperature helium-cooled, coated-particle-fuelled reactor in the United States of America. The power output from the reactor is coupled with a steam-driven turbine-generator unit with steam inlet conditions of 1000°F and 1450 lb/in.^{2}. The power operation phase of the reactor and turbine began in early 1967 and by midyear the entire unit was at full power and committed to commercial operation on the Philadelphia Electric Power Station. The plant displayed very successful power operation during the remainder of 1967. The overall performance of the plant for both steady-state and transient operation was excellent. The performance of the coated-particle fuel and the associated fission product trapping system was orders of magnitude better than design expectations. The mechanical components (i.e. compressors, valves and control rod drives) have all performed well during this initial power operation phase. In addition, very successful results have been obtained in maintaining the helium impurities in the primary system below parts-per-million levels. Typical operating parameters that were maintained are: steam temperature 1000°F; steam flow 385,000 lb/h; steam pressure 1450 lb/in.^{2}; generator output 44.2 MW(e); reactor output 113.8 MW(th); reactor out temperature 1313°F; reactor in temperature 649°F; helium pressure 333 lb/in.^{2}. In early 1968, after completing 169 full-power days, the plant was shut down to conduct planned fuel inspections. The fuel that was inspected by in-core observations and gamma scanning did not show any physical change from core loading inspections. However, during this fuel inspection operation one element of the 804 was found not to be purging properly. This element was removed from the core by means of a special tool and was found to be cracked. During the inspection program, another element was inadvertently dropped 12 ft into the reactor. Both the cracked and the dropped elements were successfully removed from the reactor, canned in their metal spent fuel storage containers and shipped for detailed inspection. 4 references. (auth)

37397 PRESTRESSED CONCRETE PRESSURE VESSELS FOR HINKLEY POINT "B" AND HUNTERSTON "B". Hay, J. D. (Nuclear Power Group Ltd., Knutsford, Eng.); Eadie, D. McD. pp 501-16 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The four vessels now being constructed at Hinkley Point "B" and Hunterson "B" sites each contain an AGR producing 625 MW(e). The basic design principles and construction methods which are equally applicable to HTR reactors, profited from design and construction experience at Oldbury. A comparison of the vessel parameters is made and basic differences from Oldbury are discussed. The single-channel access design of the reactor radically affects the design of the end slab of the vessel, and alternative methods as well as the adopted method of dealing with this problem are considered. The prestressing system is described together with the reasons for its adoption. A one-tenth scale model of the vessels has been built and tested; a description of this work is given together with an analysis of the test records and the evidence gained from inspection during the careful demolition of the tested structure. The integration of the construction of the vessel into the overall station planning and programming is briefly explained. Construction techniques are based upon experience at Oldbury, in particular the design of the tendon anchorages has been improved, following extensive research and development which is described as also is the method of erection of the lower anchorage beams. The test work carried out to substantiate the method of grouting underneath the vessel liner, and the full-scale trials of the concreting of the congested standpipe zone are described. The proposed instrumentation and pressure testing of the vessels is outlined, and constructional progress and problems to date reported. 6 references. (auth)

37398 RESULTS OF TESTS OF THE GAS CIRCULATOR FOR THE FIRST CZECHOSLOVAK NUCLEAR POWER STATION. Svoboda, V.; Masata, M. Strojirenstvi, 19: 100-6(Feb. 1969). (In Czech).

The principal parameters of a gas circulator designed and built for the first Czechoslovak nuclear power station by the CKD are described. The power station has a gas-cooled reactor and carbon dioxide is the coolant. The methods used to test the circulator and measures taken to eliminate its deficiencies are discussed. The plant can now supply circulators with rotors with various numbers of blades. (JPRS)

37399 STUDY OF TEMPERATURE SHOCKS IN GAS-COOLED REACTORS. Gregor, Jiri; Martinek, Jan (Skoda Works, Pilsen, Czech.). Nucl. Eng. Int., 14: 573-7(July 1969).

Theoretical and experimental research on thermal stresses in the ducts for the primary circuit of the first Czechoslovak nuclear power station is described. (UK)

37400 POWER REACTORS, 1969. Nucl. Eng. Int., 14: 109-26(Feb. 1969).

A directory is presented, complete with index, tabulating details of the world's power reactors, either built, under construction, or planned. It covers type of reactor and contractual data, technical parameters, and progress schedules. (UK)

37401 ASPECTS OF SWEDISH WATER REACTORS FOR USE AS SMALL AND MEDIUM-SIZE POWER REACTORS. Haga, I. (Aktienbolaget Atomenergi, Stockholm). pp 129-34 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The reactor work in Sweden has been concentrated on both boiling-light-water and boiling-heavy-water systems, based on experience with light-water reactors and with the Ågesta plant which has been operating successfully for six years. As far as the potential development of small and medium-power reactors is concerned, appreciable increases in performance are expected because reactors already existing in this range of sizes were built using designs that are very conservative in comparison with present technology. Although the generating costs' break-even point of natural uranium BHWRs with LWRs is today above the small and medium-power size range, the expected future reductions, particularly in fuel fabrication and reprocessing costs, will displace this point towards smaller unit sizes. This is valid for direct cycle BHWRs, and it is assumed that the operating experience with the Marviken will prove the reliability of a direct heavy-water steam cycle. Any future increase in the uranium prices will favor the BHWR compared with the BWR, and displace the break-even point towards even smaller sizes. The additional attraction of the natural uranium BHWRs is the independence from suppliers of enriched uranium. At unit outputs above 200 to 300 MW(e) the slightly enriched BHWRs would be expected to be competitive with light-water reactors. A special integrated PWR design for about 100 MW(e) output is described, as proposed by AB Atomenergi. 3 references. (auth)

37402 THE PRESENT ELECTRIC POWER SITUATION IN GREECE. Andreadis, C. (Public Power Corp., Athens). pp 135-9 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The Greek Government created the Public Power Corporation (PPC) in 1950. This corporation is authorized to own and operate an integrated national grid and to administer the national power program. By the end of 1967, total installed capacity in the interconnected system was 1420 MW which for critical hydrological conditions corresponds to 1206 MW. In addition, there were 81 power stations in isolated systems with a total installed capacity of 99 MW. Total net generation was 6700 G Wh, or 700 kWh per capita. The corresponding numbers in 1956 were 1400 GWh per capita respectively. A 15.2% average rate of increase of power generation is expected up to 1972, which reflects the development of industry according to the Government Plan. Net generation in 1972 is expected to be 12,730 GWh in the interconnected system and 375 GWh in the independent stations, which corresponds to about 1700 MW capacity in system additions. The existing capacity distribution for lignite-fired (33.4%), oil-fired (22.1%) and hydroelectric plants (44.5%) by 1972 will be 26.8, 41.8 and 31.4% respectively. The comparative oil-fired and nuclear power plant capital and generating costs are estimated. (auth)

37403 SIZE-SELECTION CONSIDERATIONS FOR NUCLEAR POWER PLANTS IN DEVELOPING COUNTRIES. Effat, K. E. A. (Atomic Energy Establishment, Cairo). pp 141-7 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

A number of factors affecting the choice of optimum size for nuclear power plant in developing countries are discussed. These include: the shortage of capital investment funds in developing countries, and consequently the preference for investing in projects giving rapid economic return; the need for an incentive to develop home industry and manpower; and the reactor plant suppliers. For the developing countries, at least for a number of years to come, the most appropriate reactor sizes would be in the range of 100 to 300 MW(e) for the first unit. Some data relative to UAR power production and forecasts are also included. 7 references. (auth)

37404 SCOPE FOR SMALL AND MEDIUM-SIZE POWER REACTORS IN INDIA. Bhatnagar, P. K. (Dept. of Atomic Energy, Bombay). pp 3-12 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

India has chosen reactors of 200 MW(e), and is at present constructing three power stations. It is planned to install about 15 million kW of thermal power consisting of both coal-fired as well as nuclear stations up to 1980 to 81. The projected growth rates of the grids in India indicate that reactor units larger than 200 to 300 MW(e) may not be considered for construction for some time to come. The number of such units that can be built in India is currently being examined before larger size reactors will be considered. The extent of the contribution from nuclear power will depend on its competitiveness with coal-fired stations. The generation costs from nuclear stations are compared with those from coal-fired stations. (auth)

37405 AN EVALUATION OF D_2O- AND H_2O-REACTORS AS A SUITABLE ENERGY SOURCE FOR DEVELOPING COUNTRIES. Maerkl, H.; Huenlich, W. (Siemens Aktiengesellschaft, Erlangen, Ger.). pp 17-25 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

A good deal of the nuclear development effort of Siemens has been directed to small and medium-size power reactors in recognition of their importance for meeting the present and future energy demand, especially for developing countries. Both H_2O- and D_2O-PWRs of proven technology covering the power range from 80 to 300 MW(e) are being offered on a firm price basis. The technical features and economic aspects of these reactors are described. Special consideration is given to the criteria important for selecting the reactor type most suitable for conditions in countries with a small grid: economic potential; foreign exchange requirements; fuel supply security; domestic uranium and/or thorium resources; use of bred plutonium; and participation of domestic industry. H_2O- and D_2O-reactors are appraised with regard to these criteria. A two-type strategy of natural uranium D_2O-reactors and thorium D_2O converters (or breeders) with plutonium as the initial fissile inventory and make-up is found to offer some attractive advantages. 3 references. (auth)

37406 PROSPECTS OF SMALL AND MEDIUM-SIZE POWER REACTORS IN PAKISTAN. Nurul Islam, A. B. M. (Pakistan Atomic Energy Commission, Karachi). pp 27-38 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The existing electric power situation in Pakistan is surveyed after briefly describing the historical development of power in the two provinces of the country. Forecasts of future power requirements, and type and unit size of proposed generating plant additions recommended in the 20-year (up to 1985) master plans drawn up by consultants to the major electric utilities are reviewed. Statistics of present and future costs of conventional fuels as a basis for comparison with nuclear stations. A case study of nuclear versus conventional plant under East Pakistan conditions is mentioned to establish the competitiveness of medium-sized reactors under local conditions. The necessity of the early introduction of medium-sized power reactors vis-à-vis the necessity of conservation of the country's natural gas resources is commented upon. Technical recommendations are then made to potential reactor supplier countries to make small and medium-sized reactors more attractive (cost-wise and construction-wise) to the developing countries. (auth)

37407 ELECTRIC POWER IN THE REPUBLIC OF ARGENTINA: CURRENT SITUATION AND EXPANSION PROGRAMS. Csik, B. J. (Comision Nacional de Energia Atomica, Buenos Aires). pp 39-42 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969. (In Spanish).

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The current electric power system and expansion program in Argentina are described. The Atucha and Cordoba Nuclear Power Projects, as well as other possibilities for nuclear power, are briefly discussed. (auth)

37408 BRIEF SURVEY OF THE MEXICAN ELECTRICAL SYSTEMS AND THE POSSIBILITIES OF SMALL AND MEDIUM-SIZE NUCLEAR POWER PLANTS. Eibenschutz, J. (Comision Federal de Electricidat, Mexico). pp 43-9 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969. (In Spanish).

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

Mexico has a large number of isolated electrical networks. Among these, ten have a capacity in excess of 50 MW. The largest is the Central System with 2000 MW of installed capacity, 75% in hydroelectric stations. At present the largest units in the Central System are the four 180-MW generators of the Infiernillo Hydroelectric Plant; there is one 150-MW thermoelectric unit in the same system and four more units of the same size are being installed, two of them in the Western System. Plans for the expansion of the Central System call for the addition of the first 300-MW unit about 1971. The Comisión Federal de Electricidad is studying the advisability of installing nuclear units of 500 MW or more in the Interconnected Central System. For the rest of the networks additions are planned with units having capacities of 75 MW or less. Since fossil fuel prices are expected to rise, it would be interesting to consider smaller nuclear units. The published prices for units of the size considered in this panel are not competitive; nevertheless it is reasonable to expect a decrease in unit cost if a market develops. It is proposed that the International Atomic Energy Agency organize an "international purchasing consortium" that would bring together a number of interested countries requiring nuclear power plants in the 75 to 300 MW(e) range. A preliminary study among these countries would be carried out and as a result a number of equal units to be purchased jointly could be defined. Negotiations with reactor manufacturers could then begin for a number of equal units with great advantage to both users and suppliers. (auth)

37409 CURRENT STATUS OF THE POTENTIAL OF SMALL NUCLEAR PLANTS IN THE UNITED STATES OF AMERICA. Petretic, G. J. (Div. of Reactor Development and Technology, Washington, D. C.). pp 51-6 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The present status of the potential of the small power reactor in the U.S. is briefly discussed. Plant and operating costs are reviewed, and studies are summarized. 6 references. (auth)

37410 MARKETS, CHARACTERISTICS AND POTENTIAL OF THE VULCAIN REACTOR. Maldague, P.; Storrer, J.; de Waegh, F. (S. A. Belgonucleaire, Brussels). pp 57-75 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The Vulcain program has been set up with the aim of developing a water reactor specially designed to be economic in the range of small and medium-power outputs with a view to its application in developing countries. The potential market for small and medium-size nuclear power stations has been investigated in detail. This market is essentially a function of the specific investment costs ($/kW(e)) of the nuclear power plants, and appears to be substantial within the range of costs that can be achieved at present. On the basis of the BR3/Vulcain achievements, BelgoNucléaire during the last two years has prepared and fully priced a reference design for a complete Vulcain nuclear power plant of 280 MW(th) and a net output of 87 MW(e). This design has been extended to cover the complete range of power outputs from 60 to 300 MW(e), using units of 60 to 150 MW(e). The main technical and economic data of these plants are presented. The specific investment costs range from 160 to 300 $/kW(e) according to size and local conditions. The corresponding total cost per kWh ranges from 5.5 to 10 mill. The particular advantages of twin unit power plants are emphasized. The Vulcain reactors have a particularly attractive potential in the fuel cycle field. The specific core performances are high and enable a high plant availability and a reduced fuel cycle cost. The

replacement of the entire core about every two years gives the plant operator the entire freedom to select for each refuelling a set of the most suitable characteristics for the new core, both on technical and economic grounds. The potential of Vulcain as a burner of plutonium-enriched fuels is particularly attractive, considering currently forecast prices of plutonium in the decade 1970 to 80. 6 references. (auth)

37411 CANADIAN SMALL REACTOR ASSESSMENT. Lennox, C. G. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). pp 77-86 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

An assessment was made by Atomic Energy of Canada Limited in 1965 to 67 on small reactors. The market for units of size 500 kW(e) to 30 MW(e) was examined up to 1980. Process-heat requirements were also listed. The Canadian market for small electric generators indicates that a size of 500 kW is most in demand, about 50 units per year being required in 1980. For process heat units the most popular steam rating will be 100,000 lb/hr, about 50 units per year also being required. Three reactor concepts have been evaluated and costed at a thermal rating of 30 MW (102,000 lb/h). One is an indirect cycle PWR, one a direct cycle BWR and one a direct cycle superheater. Near-term technology is assumed, system simplicity and low capital costs have been emphasized. Capital costs as electric generators at 8 MW(e) vary from 330 to 390 $/kW(e) and as process-heat units at 102,000 lb/h from 11 to 13 $/lb h. Although these specific capital costs represent a considerable reduction over previously published values they still do not meet the competition in normal industrial application, and further development work is required. (auth)

37412 INTERMEDIATE-SIZED, HEAVY-WATER-MODERATED REACTORS. Lennox, C. G. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). pp 87-94 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The interest Atomic Energy of Canada Limited has in the field of intermediate-sized reactors (100 to 400 MW(e)) is summarized. Preliminary market analyses have indicated that a unit size of 250 MW(e) would be very popular, and that developing countries would have a large demand for power units of this size in the 1980s. Parameters are given for each of four intermediate-sized CANDU (natural uranium, D_2O) reactors built or under construction. Capital and unit energy costs trends are given. 28 references. (auth)

37413 SPANISH ELECTRICAL SECTOR. Palacios, L.; Pisano, R. (Junta de Energia Nuclear, Madrid). pp 95-102 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969. (In Spanish).

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The electrical utility industry in Spain is largely in private hands. The country is divided into six zones, each roughly supplied by one utility. Details are presented of the demand of all zones during the last few years and forecasts up to 1980. The structure of the supply of electricity is explained, as well as plans for additions of installed power up to 1980. Where possible, indication of the station sizes is included. As hydroelectric power still predominates in Spain, the geographical distributions of supply and demand do not coincide. Figures are given of the energy exchanges between zones, and the capacity of the interconnected grid. Some information is also given on the price system and the cost of coal and fuel oil, as well as transmission costs. Preliminary estimates on the probable size of nuclear additions are presented. It is concluded that units of 300 MW(e) or smaller would be desirable for some of the zones, whereas 500 MW(e) or more could be accommodated in areas close to industrial load centers. Mention is also made of the Balearic and Canary Islands where small units are the only possibility. 5 references. (auth)

37414 BRITISH STEAM-GENERATING HEAVY-WATER REACTOR FOR MEDIUM-SIZE POWER STATIONS. Greenlees, F. M. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 103-20 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The general features and design of the steam-generating heavy-water reactor are described. Capital costs and a breakdown of generating costs for medium-size units are given. (auth)

37415 ELECTRIC POWER IN ISRAEL. Nelken, M. (Israel Electric Corp. Ltd., Haifa). pp 121-8 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The current electric power system and expansion pattern are briefly discussed. Some data are given on fuel and capital costs, and the current and future size of generating units is discussed. (auth)

37416 INSTITUTT FOR ATOMENERGI'S PROGRAMME IN NUCLEAR POWER TECHNOLOGY. Ager-Hanssen, Henrik (Institutt for Atomenergi, Kjeller, Norway). Tek. Ukebl., 116: 418-22(Apr. 10, 1969). (In Norwegian).

Institutt for Atomenergi's programme in nuclear power technology is summarized with main emphasis on the cooperation with the State Power System (Statskraftverkene) and Norsk Hydro on a project study for a 500 MW(e) nuclear power plant. Siting of nuclear power plants in rock is discussed and the possible advantages of using the rock to various degrees in the plant construction are identified. (auth) (Norway)

37417 COMPARISON OF CALCULATION TO IN-CORE ACTIVATION MEASUREMENTS OBTAINED DURING THE SHIPPINGPORT PWR-2 SEED-1 LIFETIME. Crawford, John A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 247-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37418 TRANSIENT PRESSURES GENERATED BY CHECK-VALVE CLOSURE AT SHIPPINGPORT: ANALYSIS AND TEST RESULTS. Murphy, J. H.; Redfield, J. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 348-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37419 MODELS FOR FUEL-CYCLE ANALYSIS IN LARGE FAST BREEDERS. Hirons, Thomas J.; O'Dell, R. Douglas (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 38(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37420 ^{235}U IN THE NUCLEAR POWER UNIVERSE OF THE NEXT FIFTEEN YEARS. Geller, Leonard; Gueron, Henri M. (S. M. Stoller Associates, New York). Trans. Amer. Nucl. Soc., 12: 38-40(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37421 MATRIX EXPONENTIAL CALCULATIONS AND COMPARISON WITH MEASUREMENTS OF ISOTOPIC CONCENTRATIONS IN YANKEE CORE I. Krug, H. E. (Westingouse Electric Corp., Pittsburgh); Nodvik, R. J.; Corbett, J. A.; Azziz, N. Trans. Amer. Nucl. Soc., 12: 52-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37422 EVALUATION OF FUEL ACCOUNTABILITY METHODS APPLIED TO YANKEE FUEL. Nodvik, R. J.; Guthrie, C. E.; Corbett, J. A. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 92-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37423 AEC LICENSING REQUIREMENTS FOR OPERATORS OF NUCLEAR PLANTS. Kelly, Frank L. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 14(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37424 ROLE OF THE UNIVERSITY IN TRAINING NUCLEAR POWER PLANT OPERATORS. Remick, Forrest J.; Penkala, John L. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc., 12: 14(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37425 COMPREHENSIVE TRAINING PROGRAMS FOR THE NUCLEAR PLANT STAFF. Beach, R. R. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 12: 14-15(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37426 THE YANKEE COMPANIES' EXPERIENCE WITH STAFFING AND TRAINING OF NUCLEAR POWER PLANTS. Johnson, W. P. (Yankee Atomic Electric Co., Boston). Trans. Amer. Nucl. Soc., 12: 15(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37427 THE NUCLEAR PERFORMANCE OF THE SAXTON PARTIAL PLUTONIUM CORE. Orr, W. L.; Thompson, R. L.; Colombo, R. W. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 230-1(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37428 N REACTOR-WPPSS COMPLEX: OPERATING PERFORMANCE. Leitz, Emil E. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 324(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37429 TORNADO CONSIDERATIONS FOR THE SPENT-FUEL STORAGE POOLS OF LWR POWER PLANTS. Doan, Phung Lien (United Engineers and Constructors, Inc., Philadelphia). Trans. Amer. Nucl. Soc., 12: 167-8(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37430 REPLACEMENT HAFNIUM CONTROL RODS FOR THE BONUS REACTOR. Tolson, G. M. (Union Carbide Corp., Oak Ridge, Tenn.); Davis, G. R. Trans. Amer. Nucl. Soc., 12: 165-6(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37431 RELIABILITY OF A COMPLEX SAFETY INJECTION SYSTEM FROM DIGITAL SIMULATION. Brunot, W. K. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 169-70(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37432 DEVELOPMENT AND APPLICATION OF A RELIABILITY DATA COLLECTION PROGRAM IN NUCLEAR POWER PLANTS. Gekler, W. C. (Holmes and Narver, Inc., Los Angeles). Trans. Amer. Nucl. Soc., 12: 170-1(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37433 SAFETY ASSESSMENT OF AUTOMATIC AND MANUAL PROTECTIVE SYSTEMS FOR REACTORS. Green, A. E. (United Kingdom Atomic Energy Authority, Risley, Eng.). Trans. Amer. Nucl. Soc., 12: 172-3(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37434 ANALYSIS OF POPULATION CHARACTERISTICS OF NUCLEAR POWER PLANT SITES. Cottrell, Wm. B.; Bryan, R. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 173(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37435 A METHOD FOR DETERMINING CONSERVATISM OF EARTHQUAKE DESIGN CRITERIA. Davis, Harold S. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 173-4(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37436 RESPONSE SPECTRUM APPROACH TO EARTHQUAKE RESPONSE OF NUCLEAR POWER STATION APPENDAGES. Wesley, D. A. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 174-5(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37437 PREVENTIVE MAINTENANCE IN NUCLEAR PLANTS. Snyder, Duane A. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 175-6(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37438 AEC QUALITY ASSURANCE CRITERIA FOR LICENSED NUCLEAR POWER PLANTS. Morrison, W. M. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 177(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37439 THE AEC'S INSPECTION PROGRAM FOR QUALITY ASSURANCE DURING CONSTRUCTION. Kornblith, L. Jr.; Reinmuth, G. W. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 177-8(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37440 PLUTONIUM RECYCLE STUDIES IN THE SENA REACTOR [266 MW(e)-PWR]. Debrue, J. (Centre d'Etude de l'Energie Nucleaire, Mol-Donk, Belg.); Deramaix, P.; de Waegh, F. Trans. Amer. Nucl. Soc., 12: 33-5(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37441 COMPARISONS BETWEEN SIMPLE CALCULATIONS AND MEASUREMENTS OF YANKEE ROWE FUEL INVENTORIES. Kern, R.; Bonaca, M. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 12: 32-3(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37442 AN ANALYSIS OF URANIUM FUEL IRRADIATED IN YANKEE REACTOR. Matsen, R. P.; Busselman, G. J.; Holeman, R. H.; Liikala, R. C. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 31-2(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Power Reactor Development

Refer also to abstracts 35985 and 36295.

37443 (AECL-3369) FUTURE OF HEAVY-WATER REACTORS. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River (Ontario)). June 1969. 6p. (DL-98; CONF-690615-1). Dep. CFSTI. CAN $0.50.
From 9th Annual Nuclear Association Conference, Montreal, Canada.
It is forecast that heavy water as moderator and thorium as fuel will make well-designed reactors stay with the competition forever. The fuelling cost can be so low that such reactors will be used not only for generating electricity on a large scale but also for desalting water and for providing energy for industrial processes. In the near future when reactors of 1500 MW(e) capacity are designed it seems likely that an organic liquid coolant will be used to give a net station efficiency of 39%. (auth)

37444 (ANL-7577) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, APRIL-MAY 1969. (Argonne National Lab., Ill.). July 7, 1969. Contract W-31-109-eng-38. 206p. Dep. CFSTI.
Highlights of project activities are summarized for the report period. Fuels, physics, and components development for the LMFBR program are described. Fast reactor physics measurements with the ZPR-3 and ZPPR are reported. Modifications on ZPR-6 and ZPR-9 to permit operation with Pu loadings are nearly complete. Research and development programs using the EBR-2 are reviewed. General reactor technology development activities include fuels and materials studies and chemistry and chemical separations processes evaluations. Nuclear safety studies include TREAT operations, kinetics analysis, and energy release problems. (H.D.R.)

37445 (EUR-3882(Add.1)) SQUID-360: A MULTIGROUP DIFFUSION PROGRAM WITH CRITICALITY SEARCHES FOR THE IBM-360. Salina, E. (FIAT, Turin (Italy). Sezione Energia Nucleare). July 23, 1968. 7p. Dep.
The latest features embodied in the program SQUID-360 running on the IBM-360/65 at CETIS, CCR EURATOM, Ispra are described. (auth)

37446 (EUR-4067) CODE ORION II: OPTIMIZATION CODE OF AN ORGEL REACTOR ASSOCIATED WITH AN ELECTRICITY GENERATING PLANT. Boettcher, W.; Haijtink, B.; Lafontaine, F.; Tauch, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 28, 1968. 84p. (In French). Dep.
The ORION II code, to be used for optimizing an ORGEL reactor power plant, is described. The calculation procedure is first indicated, then the range of validity of the mathematical model, followed by the hypothesis used at each stage in the program. The optimization technique applied to eight independent variables as well as the different types of calculations possible with this code are specified. One part specially prepared for the user describes how to use the code, the input data, the output and the presentation

of the results. An example of an optimization of seven independent variables is given as an appendix. (auth)

37447 (GA-6586) EBOR: THE EXPERIMENTAL BERYLLIUM OXIDE REACTOR. Wellhouser, H. N.; Peterson, K. M. (Gulf General Atomic, Inc., San Diego, Calif.). July 1965. Contract AT(04-3)-187. 20p. Dep. CFSTI.

The Experimental Beryllium Oxide Reactor facility design parameters are summarized. Characteristics of primary EBOR components and systems are described, and the basic program objectives in the use of the facility are discussed. (H.D.R.)

37448 (STI/PUB-197) ADVANCED AND HIGH-TEMPERATURE GAS-COOLED REACTORS. Proceedings Series. Proceedings of a Symposium held in Juelich, 21-25 October, 1968. (International Atomic Energy Agency, Vienna (Austria)). 1969. 919p. (In English and French). (CONF-681008). IAEA: $2100; Austrian Schilling 543,-; £8.15.0; F. Fr. 102,90; DM 84,-.

Information concerning advanced and high-temperature gas-cooled reactors is presented under the following main headings: experience with reactors in operation or under construction; new and advanced designs of HTRs; the application of gas turbines; safety; major components and equipment; fuel elements and materials; fuel cycle; and economics and potential. Separate abstracts are included for 45 of the 52 papers presented. Seven of the papers were previously included in NSA and may be located in the Report Numbers Index as: ORNL-TR-3013; ORNL-TR-3011; EURFNR-580; EIR-141; ORNL-TR-3012; CEA-CONF-1091; and ORNL-TR-3010. (D.C.C.)

For abstracts of individual papers see: 36295, 37391-37397, 37450-37453, 37485, 37490-37492, 37508-37523, 37553-37555, 37564-37567, 37602-37606, and 37678.

37449 NUCLEAR DEVELOPMENT IN S. AFRICA. Roux, A. J. A. (Atomic Energy Board, Pretoria). S. Afr. Mining Eng. J., 79: 1271-3(Nov. 29, 1968).

The nuclear power station which comes into operation by 1977-78 would be an economic proposition for South Africa. After the introduction of the first nuclear power station the basis of power development in South Africa could be very largely nuclear. At least half of the new installed capacity from 1980 to the end of the century could be nuclear. For South Africa to benefit from fast breeder reactor economics, it must move rapidly to be ready by the mid-80's. The development of processes and technology for the manufacture of U metal and UO_2 were advanced in pilot plant studies; the basic information is now available for large scale production of these materials. The development of processes were extended to cover the manufacture of UC. Studies with the Safari-1 Reactor must be seen as the forerunner of the manufacture of nuclear fuel elements. In South Africa the introduction of the Purlex process into U extraction plants has reached an advanced stage; the final product is of the higher grade of purity and costs less and thus can be used in subsequent processes for production of UO_2 and UF_6. Over the past 10 yr an approximate annual average of R3 million has been spent on nuclear research. In terms of expenditure in 1966 this represents ~0.04% of the gross national product. The activities of the Atomic Energy Board will have to be expanded to keep pace with development in nuclear energy. (BBB)

37450 DESIGN FEATURES OF THE 300-MW THTR POWER STATION. Mueller, H.-W. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). pp 135-53 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The essential design data of the THTR are: reactor heat 750 MW(t); He pressure 40 atm; net station output 307.5 MW; HP steam conditions (turbine inlet) 181 atm/530°C; reheat steam conditions (at IP turbine inlet) 47.2 atm/530°C; power density core 6 MW(th)/m^3. The complete primary circuit with steam generators, blowers, absorber rods, instrumentation etc., is enclosed in a prestressed concrete pressure vessel with only part of the fuel-handling system and the gas-purification plant outside. The core cavity contains 675,000 spherical fuel elements in a loose packing. The development of the spherical fuel element has now progressed sufficiently for it to be used without any risk in a full-scale power station. The advantages of this type of fuel element are: continuous on-load re-fuelling; adaption of economical fuel cycles with the same type of fuel element for all sizes of reactors; uniform high burn-up of all fuel elements; no excess reactivity to compensate burn-up of the fuel; and good dynamic operational characteristics. Particular emphasis has been placed on the graphite reflector surrounding the core in order not to endanger mechanical stability, due to shrinkage and/or expansion by fast neutrons and high temperatures. Extensive strength tests were carried out with graphite models on small and full scales. The main feature of the fuel-handling movement (downwards with gravity, upwards pneumatically) has been proved in AVR and re-adopted for THTR. Futhermore, a new outstanding concept of measuring the burn-up of spent fuel has been developed by applying a small reactor facility. Part of the absorber rods are inserted directly into the pebble-bed core for long shut-down purposes; for daily and/or weekly load changing requirements control rods moving inside the reflector blocks are envisaged. Contrary to the AVR, downward flow of the coolant is adopted within the core, thus preventing the fuel elements rising and providing a "cold chamber" above the core. The essential safety criteria of the THTR are: use of coated particles; graphite as moderator and structural material; inert coolant gas; high heat capacity; low excess reactivity; negative temperature coefficient; application of a concrete pressure vessel. The chemical and physical properties and the dynamic behavior of the core render a melt-down accident with its consequences of an extreme release of fission products impossible. The maximum possible activity accident (the total release of the primary coolant gas activity) does not cause any dangerous conditions to the surrounding. An additional containment or biological shield is thus not required. 8 references. (auth)

37451 DESIGN OF A LOW-ENRICHMENT, HOMOGENEOUS, HELIUM-COOLED REACTOR WITH OFF-LOAD REFUELLING. Brown, G.; Branson, P. B.; Mills, C. P. (Atomic Power Constructions Ltd., Surrey, Eng.). pp 197-221 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The reactor system described uses coated-particle fuel in a graphite-moderated, He cooled reactor utilizing the low-enrichment U-Pu fuel cycle. Prismatic fuel pins are used in closely pitched coolant channels machined in the graphite core blocks to give a pseudo-homogeneous core arrangement. The He coolant flows upward through the core in a single pass, which leads to a simple arrangement of the core and associated gas circuit. Each graphite core block contains a number of fuel pins, and blocks are built up to form integral columns which are handled in single units, a number of them being changed at each refuelling. Thus the moderator is replaced with the fuel, which avoids the normal limitations set by graphite dose considerations and permits a high specific fuel rating to be used. Refuelling is done off-load, all fuel being removed and replaced through a single access hole in the concrete pressure vessel. This arrangement leads to a simple design of fuelling machinery. Triple-coated particles with UO_2 kernels of about 650 μm diameter are used; these are loosely bonded to give a heavy metal density of some 1.2 g/cm^3 in the fuel pins. A relatively high ^{235}U enrichment is required because of the homogeneous nature of the core, but this is offset by a high conversion factor giving a good net rate of Pu production, and low fuel-cycle costs are obtained. Capital costs are also low because of the simplified core and refuelling arrangements. Operational characteristics of the design are good. Fuel and moderator temperature coefficients are both substantially negative, which eases reactor control problems, and the reactivity required for Xe override is small so that full override can be provided without an undue penalty in fuel costs. 4 references. (auth)

37452 ACTIVITIES IN THE FIELD OF THORIUM REACTORS IN THE FEDERAL REPUBLIC OF GERMANY. Schulten, R. (Kernforschungsanlage, Juelich, Ger.); Hecker, R.; von der Decken, C. B. pp 817-29 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The Nuclear Research Center (KFA) Jülich is carrying out studies on the utilization of Th fuel cycles in heavy-water reactors, molten-salt reactors, and high-temperature reactors in co-operation with the firms Siemens, INTERATOM, and Brown Boveri/Krupp Reaktorbau GmbH. These studies are intended to provide information on the economy of Th utilization. The first Th/U reactor in the Federal Republic of Germany is the AVR reactor which came into operation in 1967. The most important points of experience to date are that there is little He leakage, impurity levels are slight, and that the activity of the fuel cycle is remarkably low. In 1963 in co-operation with the firm Brown Boveri/Krupp Reaktorbau GmbH the KFA started development and construction of a 300-MW power plant with a Th/U fuel cycle. It is the intention of the Federal Republic of Germany to carry out in co-operation with the firms Gutehoffnungshütte Sterkrade AG, Brown Boveri/Krupp Reaktorbau GmbH, and the KFA Jülich GmbH a development and construction program for a 600-MW prototype reactor with He turbine. Parallel to the development program for the design and construction of reactors with Th fuel cycles, the KFA is carrying out in co-operation with the most important firms research and development into the reprocessing

and refabrication of fuel elements for these reactors. 7 references. (auth)

37453 ECONOMIC EXPLOITATION OF GAS-COOLED REACTORS. Marnet, C. (Brown Boveri et Cie, Mannheim, Ger.); Bell, P. R. P.; Eltham, B. E. pp 859-77 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

Information about power station proposals which can currently be offered in Germany and similar European countries is presented. Costs of capital plant and of the fuel cycle are given for a range of sizes and a range of applications, including certain mixed schemes in which the plant supplies steam for process as well as electricity. Nuclear power station costs, both capital and running, can vary according to local circumstances and the economic assumptions which are incorporated in the ground rules. To illustrate these effects, the changes that have occurred in Dungeness "B" generating costs since construction started in 1965, are described, and then the differences in costs for German and British conditions are analyzed. The gas-cooled reactor system is not a static one and technical improvements are continually being made. The timing and merit of variants to the gas-cooled reactor system are currently being considered. Of fairly immediate application are those improvements which retain the concept of the steel-canned fuel cluster with some reduction in capital cost and fuel inventory. Longer-term evolution is towards a fuel based on the coated particle, possible with a change of coolant to helium. Such systems, which incorporate the present experience gained with the gas-cooled reactor system but with greatly increased rating, will be available for commercial exploitation in the 1970s. 10 references. (auth)

37454 NUCLEAR REACTOR. (to EURATOM). French Patent 1,361,744. Filed July 4, 1963.

A nuclear reactor having multiple elongate fuel elements in parallel elongate channels is described. In order to obtain a more even distribution of thermal neutron flux in the direction of the channel length, the fissile material in some of the channels is replaced by a moderating material over portions of the channels on each side of a plane perpendicular to the length of the channels and intermediate in the length, preferably the plane of symmetry of the reactor. (NPO)

37455 RADIATION CONTROL AT TOKAI NUCLEAR POWER STATION. ACTUAL CONDITION AND VARIOUS PROBLEMS LEADING TO NORMAL OPERATION. Nishikawa, Yoshiyuki (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan); Tanaka, Mizue. Hoken Butsuri, 4: No. 1, 13-23(Mar. 1969). (In Japanese).

The experience gained at Tokai station is compiled. Conditions of radiation control and the problems during the period from the initial stage of operation to normal operation of the station are presented. (auth) (NSA of Japan)

37456 MARVIKEN POWER STATION. Bergstroem, G.; Nordinder, O. (Aktiebolaget Atomenergi, Sweden). Nucl. Eng. Int., 14: 561-7(July 1969).

The 140 MW(e) HBWR described was designed to permit the introduction of nuclear superheating, which would increase the power to 200 MW(e). Design features described include the moderator and coolant flow, fuel elements, control rod drives, and the fuel handling system. Aspects of reactor physics and of control and safety are discussed. Experience during the first light water test period is described. A folded chart gives a cut-away view of the reactor and lists the main parameters. Major contractors and suppliers are listed. (UK)

37457 THE NUCLEAR ENERGY 1967-1968, INTERNATIONAL DEVELOPMENT. Edman, Rune (Swedish State Power Board, Stockholm). Tek. Tidskr., 99: 393-4(1969). (In Swedish).

A review is made of the development of nuclear energy in the world except for the Eastern Hemisphere during 1967 and 1968. The trends in reactor type selection, reactor sizes and fuel supply are discussed. (Sweden)

37458 IMPACT OF STAINLESS-STEEL SWELLING ON FAST REACTOR CORE DESIGN. Finch, L. M.; Peterson, R. E. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 316-18(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37459 ENERGY CONSUMPTION: ITS GROWTH AND PATTERN. Merlin, H. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Mining Met. Bull., 62: 599-608(June 1969).

The past demands for energy and the contributions by the major sources are shown for the world and regions, and for Canada. Three forecasts of future demand are presented. By the year 2000, the world will be consuming energy at a rate of $670-700 \times 10^{15}$ Btu/year. Canada's rate is estimated at 20×10^{15} Btu/year. Electricity will increase its portion of energy from 7.5 per cent to 15 per cent, and more than 40 per cent of the primary energy will be required to generate it. World, regional and Canadian forecasts are given for total electricity generated and for electricity generated in nuclear stations. The integral world requirement for energy by the year 2000 will be over 12×10^{18} Btu. Current recoverable fossil and hydro reserves are about 18×10^{18} Btu. The total reserves are estimated to be seven times greater. World production of electricity in nuclear stations by the year 2000 will be almost three times the electricity produced in the world today. The amount of fuel consumed in generating this electricity will depend upon the types and mix of reactors installed. The heavy water reactors, alone or in conjunction with fast breeders and liquid fuel reactors, are the most efficient users of uranium and thorium resources. The heavy water reactors are also the most efficient producers of plutonium which will be required as fuel for fast breeders. (auth) (Canada)

37460 PEACEFUL USE OF NUCLEAR ENERGY. Davis, M. (United Kingdom Atomic Energy Authority, London). Atom, No. 153, 198-211(July 1969).

The following topics are discussed: the present situation with regard to nuclear power; the future; use of plutonium; fast breeder reactors; economics of nuclear power; the nuclear fuel cycle; choice of reactor; self-sufficiency in nuclear energy; and benefits of nuclear energy at least cost. (UK)

Kinetics and Dynamics

Refer also to abstract 37610.

37461 (AI-AEC-12815) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, January-March 1969. (Atomics International, Canoga Park, Calif.). May 31, 1969. Contract AT(04-3)-701. 40p. Dep. CFSTI.

ALUMINUM — reactivity worth measurement in plate-type core mockup for LMFBR
DEUTERIUM — neutron elastic scattering cross sections for, comparison of measured and calculated
FAST TEST REACTOR — neutron spectra measurements in, sodium coolant for
HYDROGEN — neutron elastic scattering cross sections for, comparison of measured and calculated fast reactor
LIQUID METAL FAST BREEDER REACTOR — core mockup for, reactivity measurements in plate-type
MONTE CARLO METHOD — neutron source distributions generation by, procedure for spatial
— neutron effective resonance cross section calculation by, mesh for fast reactor
NEUTRON CROSS SECTIONS — library for fast reactor physics calculations, description of code to read ENDF/B tapes and generate new
— calculation of fast reactor effective resonance, Monte Carlo mesh for
NEUTRON SOURCES — distributions for fast reactor physics calculations, development of Monte Carlo technique for generating spatial
NEUTRONS — spectra measurements in sodium coolant for FFTF program, use of proton-recoil technique for
— attenuation in sodium, measurement for FFTF program of
OXYGEN — neutron elastic scattering cross sections for, comparison of measured and calculated
REACTIVITY — worth measurement in LMFBR plate-type core mockup, results of
REACTORS, FAST — physics calculations for, Monte Carlo computational technique for treatment of unresolved resonance region in
SODIUM — neutron spectra measurements in liquid, use of proton recoil technique for
— neutron attenuation in, measurement of
STAINLESS STEEL — reactivity worth measurement in plate-type core mockup for LMFBR
TANTALUM — reactivity worth measurement in plate-type core mockup for LMFBR
TUNGSTEN ISOTOPES W-182 — reactivity worth measurement in plate-type core mockup for LMFBR
TUNGSTEN ISOTOPES W-184 — reactivity worth measurement in plate-type core mockup for LMFBR
TUNGSTEN ISOTOPES W-186 — reactivity worth measurement in plate-type core mockup for LMFBR
URANIUM OXIDES UO_2 — reactivity worth measurement in plate-type core mockup for LMFBR (M.L.S.)

37462 (GA-9386) FAST REACTOR SPECTRUM MEASUREMENTS. Quarterly Progress Report for the Period Ending April 30, 1969. Young, J. C.; d'Oultremont, P.; Cerbone, R. J.; Neill, J. M. (Gulf General Atomic, Inc., San Diego, Calif.). May 15, 1969. Contract AT(04-3)-167. 36p. Dep. CFSTI.
CRITICAL ASSEMBLIES — core loading for STSF-2, atom densities and fuel geometries for
— experimental program for STSF-2, description of planned
— core for STSF-2, results of CAM calculation of neutron fluxes in
— neutron spectra measurements in STSF-3, comparison of GAFGAR calculated values with fast
NEUTRON CROSS SECTIONS — library generation for fast reactors, comparison of techniques for
NEUTRONS — spectra in fast reactors, evaluation of feasibility of two-dimensional analysis of time-of-flight
— spectra in STSF-3, comparison of measured and calculated
REACTORS; FAST — neutron time-of-flight spectra in, evaluation of feasibility of two-dimensional analysis of
— neutron spectrum calculations for, description of GAFGAR program for
— physics calculations for, comparisons of methods for neutron cross section generation for (M.L.S.)

37463 EFFECT OF DELAYED-NEUTRON DATA UNCERTAINTIES ON GAS-COOLED FAST REACTOR KINETICS. Baxter, A.; Davison, W. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 224-5 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37464 THE FREQUENCY RESPONSE OF THE NEUTRON FLUX TO PRESSURE IN A CIRCULATING FUEL REACTOR: ANALYTICAL AND EXPERIMENTAL. Robinson, J. C. (Univ. of Tennessee, Knoxville); Fry, D. N. Trans. Amer. Nucl. Soc., 12: 292-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37465 XENON STABILITY IN BOILING WATER REACTORS. Lellouche, G. S. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 298-9 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37466 ANALYSIS OF XENON TRANSIENTS IN LARGE PRESSURIZED WATER REACTORS WITH THE XENOLUX PROGRAM. Cherry, B. H.; Buck, P.; Krumbein, A. D. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 12: 299 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37467 FUEL, MODERATOR, AND REFLECTOR TEMPERATURE AND DENSITY EFFECTS ON THE EFFECTIVE MULTIPLICATION FACTOR OF A BWR. Khan, A. M. (Pakistan AEC, Karachi); Gallar, O. H. Trans. Amer. Nucl. Soc., 12: 200-1 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37468 A PRELIMINARY APPLICATION OF CRITICAL ASSEMBLY SODIUM-VOID STUDIES TO A 350-MW(e) DEMONSTRATION FAST BREEDER REACTOR. Page, E. M.; Kurosu, T. (Atomic Power Development Associates, Inc., Detroit, Mich.). Trans. Amer. Nucl. Soc., 12: 185-6 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37469 INTEGRAL TRANSPORT THEORY ANALYSIS OF SMALL-SAMPLE REACTIVITY MEASUREMENTS. McGrath, P. E.; Foell, W. K. (Univ. of Wisconsin, Madison). Trans. Amer. Nucl. Soc., 12: 188-9 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37470 ANALYSIS OF NEUTRON NOISE IN A MOLTEN SALT REACTOR OPERATING AT POWER. Fry, D. N. (Oak Ridge National Lab., Tenn.); Kryter, R. C.; Robinson, J. C. Trans. Amer. Nucl. Soc., 12: 299-300 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37471 INVESTIGATION OF SHADOWING AND ANTISHADOWING EFFECTS OF CONTROL RODS IN A TYPICAL 300-MW(e) OXIDE-FUELED FAST REACTOR. Paik, N. C.; Newmark, B. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 276-7 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37472 OVERLAPPING GROUP METHOD. Lancefield, M. J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 149-50 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37473 NUMERICAL COMPARISON OF DATA PROCESSING CODES FOR FAST REACTORS. Little, W. W. Jr. (Battelle-Northwest, Richland, Wash.); Hardie, R. W.; Schenter, R. E.; Pennington, E. M.; Hutchins, B. A.; Price, L. N. Trans. Amer. Nucl. Soc., 12: 144 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37474 INTEGER PROGRAMMING PROBLEM IN NUCLEAR PLANT OPTIMIZATION. Weisman, Joel (Univ. of Cincinnati); Holzman, A. G. Trans. Amer. Nucl. Soc., 12: 141 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37475 A SEMI-ANALYTICAL METHOD FOR INVESTIGATING TEMPERATURE FEEDBACK TRANSIENTS IN A PWR-TYPE REACTOR. Eckley, Wayne (Naval Academy, Annapolis, Md.). Trans. Amer. Nucl. Soc., 12: 20-1 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37476 SPACE-DEPENDENT NOISE WITH XENON FEEDBACK. Congdon, M. E. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 12: 238-9 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37477 THREE-DIMENSIONAL METHOD FOR DESIGN STUDIES OF XENON-INDUCED SPATIAL OSCILLATIONS. Kern, R.; Coppersmith, W. C.; Rosztoczy, Z. R. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 12: 239 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37478 FUEL TEMPERATURE COEFFICIENT DETERMINATION IN UHTREX FROM TRANSIENT EXPERIMENTS. Vigil, J. C.; Booth, L. A.; Bergstein, J. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 342 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37479 FISSION PRODUCTS IN REACTOR DYNAMICS. Woyski, Jan S. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 12: 332-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37480 GENERALIZED FORMULA FOR CALCULATION OF FISSION NEUTRONS STATIC RELATIVE IMPORTANCE. Dideikin, T. S.; Platovskikh, Yu. A.; Shishin, B. P. At. Energ. (USSR), 26: 291-2 (Mar. 1969). (In Russian).

General formulas were constructed for calculating and correlating reactivity values of a nuclear reactor. The value of neutron energy in relation to the value of fission neutron spectrum is found. It is shown that for any arbitrary nuclear reactor, the value of fission neutrons is a ratio of coefficients k_{eff}^3/k_{eff} where k_{eff}^1 and k_{eff}^3 are coefficients reactor neutron multiplication. The magnitudes k_{eff}^1 and k_{eff}^3 can be calculated using an arbitrary model which correctly evaluates the fission neutron spectra. (R.V.J.)

Control Systems

Refer also to abstract 35550.

37481 (CONF-680625-3) REACTOR INSTRUMENTATION. Trott, A. J. (Plessey Automation Ltd. (England)). [1968]. 17p. Dep.
From BNX/BNF Nuclear Power Meeting, Copenhagen, Denmark.

Instrumentation requirements for neutron flux measurements and failed fuel element detection for reactors are discussed. Required ranges for operation of instrumentation are defined; basic methods of flux density measurements are described. Components and designs for failed fuel element detection are considered. Cross sections of boron lined proportional counters, compensated and uncompensated ion chambers, and in-core flux monitoring channel assemblies are included. A schematic of an

in-core instrumentation system is given which includes flux mapping instrumentation. (M.L.S.)

37482 (EUR-4190, pp 491-504) THE MEASUREMENT OF PRESSURE DISTRIBUTION IN A PEBBLE BED BY MEANS OF ROD-SHAPED PROBES. Bedenig, D.; Merten, G. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Juelich (West Germany)).

The absorber rods developed for the THTR enter freely into the pebble bed. Special attention was given to the pressure distribution within the pebble bed which could be measured with slender probes. The results are presented in the form of diagrams (isodynes and isotaches). During the measurements various parameters as friction, specific bulk weight, static and dynamic pressure of the pebble bed, number of rods and the container geometry were taken into consideration. The evaluation of the results was carried out by taking into account the static nature of the measurements. The experiments were performed with reference to the problems of the pebble bed reactor core but there are a lot of common points with the general problems in silo techniques and soil mechanics. (auth)

37483 (ORNL-4397) ANALYSES OF TRANSIENTS IN THE MSRE SYSTEM WITH ^{233}U FUEL. Burke, O. W.; Clark, F. H. S. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26, 47p. Dep. CFSTI.

The ^{233}U fueled MSRE system was simulated on the ORNL analog computer. The simulated system was used to evaluate the existing MSRE control and safety systems when used on the ^{233}U fueled system. The pertinent results and conclusions were as follows: (1) The safety system will limit the "startup accident" so that the peak power will be 100 kw. (2) A quantity of ^{233}U sufficient to cause a reactivity change of approximately -1% δK/K when precipitated out of the fuel at some point in the system external to the core could be swept back into the core in a concentrated form without causing excessive core damage. (3) The existing controller will control the ^{233}U fueled system in a stable manner; however, an increased velocity feedback gain will be required. 4 references. (auth)

37484 (WCAP-3680-10) CONTROL OF XENON INSTABILITIES IN LARGE PWR'S. Quarterly Progress Report for the Period Ending March 31, 1969. O'Boyle, M. J. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Apr. 1969. Contract AT(30-1)-3680. 14p. (EURAEC-2098). Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Three-dimensional instability calculations, including feedback effects, were initiated and are about 70% complete. The overall core geometry of the 3-D model is that of a typical 4-loop core with 193 fuel assemblies. Three homogenized enrichments and burnable poison zones were selected by running a series of two-dimensional calculations in which the fuel enrichments and the loading patterns were varied until an acceptable power distribution was found. In parallel with the three-dimensional analysis, a two-dimensional analysis was carried out and the results show that the average plane is stable while the inlet plane is not. (auth)

37485 PERFORMANCE OF HIGH-TEMPERATURE REACTORS WITH HELIUM TURBINES. Bammert, K. (Technical Univ., Hanover); Krey, G.; Kueper, K. D. pp 331-43 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The action of the control system and the stationary part-load behavior of the nuclear power plant are shown. The dynamic control action is then discussed. The mathematical treatment of this problem with an analog computer together with the results of the calculations made for various speeds of load-changing are given. These results are compared with measurements of the dynamic behavior of a closed-cycle air turbine at quick load changing and load decrease. In addition, the control action of the combined pressure level and by-pass control is shown for characteristic disturbances, e.g. scram of the turbine and reactor, and load decrease. The start-up and shut-down processes of nuclear He turbines are described and a method of calculating the starting behavior of the plant with a digital computer is mentioned. 8 references. (auth)

37486 NUCLEAR REACTORS. Molle, Raoul Desire Joseph; Durrands, Kenneth James (to Societe Anglo-Belge). U. S. Patent 3,442,759. May 6, 1969. Priority date Feb. 16, 1966, Great Britain.

Described are a method of and apparatus for controlling reactivity in nuclear reactors by subjecting a control member to the influence of a sequence of fluid pulses, the sequence being of variable character so that the rate and direction of movement of the member can be controlled by varying the character of the sequence. The fluid pulses may be created in fluid flowing through passages in the core. (Offic. Gaz.)

37487 A MAGNETIC JACK CRDM TEST IN AN LMFBR ENVIRONMENT. Dill, Douglas L.; Flury, Ronald L. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 322-3 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37488 DEVELOPMENT AND USE OF ^{10}B FOR REACTIVITY CONTROL AT PRTR. Demmitt, T. F.; Richman, R. B.; Bloom, G. R. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 307 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Cooling Systems

Refer also to abstracts 34991, 35073, 35553, 35560, 35566, 36014, 36015, and 36017.

37489 (WCAP-2320) NUCLEAR DESIGN OF THE SAXTON SUPERHEAT LOOP. Hudec, W. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). June 1963. 82p. Dep. CFSTI.

The mockup of the Saxton superheat loop and core are described; physical dimensions and configuration are given. Values for axial bucklings, reflector savings, and reactivities are tabulated; results of power distribution measurements are shown graphically. The changes in reactivity caused by loop flooding are given as a function of fuel enrichment. Analytical procedures for obtaining power distributions and fast and thermal physics constants are discussed; calculated data are shown graphically. Effects of moderator temperature and pressure on results of critical experiments are analyzed; temperature, pressure, density, and flooding coefficients are listed. (M.L.S.)

37490 SAFETY PROBLEMS OF HIGH-TEMPERATURE GAS EXCHANGERS. Tillequin, J. F. (Societe Babcock-Atlantique, Paris). pp 409-22 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969. (In French).

See STI/PUB-197; CONF-681008.

Safety problems in connection with exchangers used with high-temperature graphite-gas plants are described. Some problems relating to design, construction or operation and the solutions adopted and progress achieved, are discussed. Much of this technical know-how can be applied in the design of future high-temperature plants. However carefully manufacturing is carried out and however efficient quality controls may be, weak spots can always occur over such a long length of tube and in such a large number of welded assemblies. Exchange design must therefore provide a means of detecting and isolating rapidly any part of an exchanger in which a leakage occurs and repairing it easily or by-passing the faulty tube during the next maintenance shut-down. (auth)

37491 RECENT FRENCH RESEARCH ON THE THERMAL INSULATION OF NUCLEAR REACTORS. Mordchelles-Regnier, G. (Societe Bertin et Cie, Paris); Micheau, P.; Pirovano, A.; Jumentier, C.; Terpstra, J. S.; Lecourt, Y.; Chave, P.; Breuille, M. pp 529-44 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969. (In French).

See STI/PUB-197; CONF-681008.

The thermal insulation of a reactor shell is generally recognized as a delicate problem to solve, because natural convection phenomena inside the insulating material make an important contribution to heat transmission. The results of general research on natural convection in a porous medium are presented. The results of trials with structures made of metal sheets and grids, used in a helium atmosphere, are also included. The general study shows that practically all insulating structures can be assimilated to a porous medium as regards the overall effects of natural convection. To clarify these effects, Bertin et Cie and La Compagnie de St-Gobain have carried out a thorough analysis of natural convection in a highly porous medium, under a EURATOM contract. Theoretical and experimental results are reported. These relate to velocity and temperature distributions in a parallelepiped cell containing a fibrous medium and subjected to a thermal gradient. The natural convection theory previously described is applied to interpretation of the variation with height of the thermal conductivity found in a heat insulator. This study, carried out by Bertin et Cie, shows that the relationships obtained can be used to deduce the local apparent conductivity of a full-scale thermal insulator from the results of trials on a medium scale. They are applicable not only to the same fluid as used in the trials, but also to different fluids. The most recent results obtained by the Compagnie des Ateliers et Forges de la Loire in their development of a metal foil and grid insulator are analyzed. 4 references. (auth)

37492 THERMAL INSULATION OF PRESTRESSED CONCRETE PRESSURE VESSELS BY "GAS WALLS." Wuerdig, P. (Deutsche Babcock and Wilcox AG, Oberhausen, Ger.); Freour, A.; Terpstra, J. S. pp 517–28 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB–197; CONF-681008.

The "gas-wall" thermal protection system, developed under a Euratom-sponsored contract by Deutsche Babcock and Wilcox and SOCIA, avoids many of the disadvantages of the conventional solutions. The objective of this contract was to develop a prefabricated assembly comprising insulation, drainplate and cooling system, to be fitted as a unit into the finished concrete vessel. The high heat resistivity achieved with the first prototypes which were cooled by water ("water walls") encouraged the design and testing of gas-cooled walls, which proved to be very effective. In these "gas walls" cooling is accomplished by cold gas which is of the same nature and under the same pressure as the reactor coolant. Thus the plant is not endangered by leakages or burst tubes and the cooling circuit can be connected with the primary circuit of the reactor. The insulation of the gas-walls consists of prefabricated packs of mineral wool arranged in layers of appropriate dimensions. The heat flux penetrating through the insulation is drained by a back plate to which the cooling pipes are welded in a meander arrangement. The gas walls were tested experimentally in the FIGARO test rig at Friedrichsfeld near Oberhausen. This installation is equipped with a pressure vessel 3.8 m in diameter and about 7 m high and allows measurements to be made on large prototype walls at gas pressures up to 40 atm. Apart from gas-wall designs for the top, bottom and cylindrical walls of a pressure vessel, designs for all associated parts, such as penetrations, supports and joints, were tested under realistic conditions. The results of these tests are reported. A price quotation relating to a complete thermal protection system for a reactor pressure vessel of the AGR type has been prepared and allows economic comparison with more conventional systems. 5 references. (auth)

37493 COOLANT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,402,257. Filed Dec. 16, 1965.

A method of reducing the radiation-induced CO_2-graphite reaction in a CO_2-cooled, graphite-moderated reactor is described. Said method comprises the addition to the coolant of a radical source selected from the group consisting of azomethane, acetone, acetyl acetone, acetaldehyde, diacetyl, diethyl ether, tetramethyl silane, trimethylamine, xylene, tertiary-butyl peroxide, tetramethyl lead, toluene, trimethyl benzene, ketene, diazomethane, ethylene, ethylene oxide, dichloromethane and acetylene, in a concentration of 200–3000 ppM by volume. If ketene is used as an additive the coolant preferably consists of CO_2 containing 0.3–1.0 vol % of CO. (NPO)

37494 NUCLEAR POWER STATION WITH CARBON DIOXIDE COOLING SYSTEM. Schabert, Hans-Peter (to Siemens Aktiengesellschaft). U. S. Patent 3,444,038. May 13, 1969. Priority date July 9, 1966, Germany.

Nuclear power station with carbon dioxide cooling system for producing electrical energy includes at least one gas turbine connected to a compressor and disposed upstream of the coolant gas inlet to the reactor, a regenerative heat exchanger connected in the coolant gas line between the compressor and the gas turbine, the primary loop of the regenerative heat exchanger being traversed by heated coolant issuing from the reactor either directly or after being relatively slightly reduced in pressure, the coolant further traversing a cooler connected in the primary loop, the coolant entering the compressor having a pressure within a range of at least 40 atmospheres absolute and 130 atmospheres absolute. (Offic. Gaz.)

37495 INTEGRAL NUCLEAR REACTOR WITH COOLANT PENETRATIONS FORMED IN A SEPARABLE MODULE OF THE REACTOR VESSEL. Rigg, Shepherd (to United Kingdom Atomic Energy Authority). U. S. Patent 3,442,760. May 6, 1969. Priority date Nov. 2, 1965, Great Britain.

An integral nuclear reactor-steam generator construction in which the pressure vessel is made in three parts, a body portion, a closure member, and an annular member clamped between the body portion and the closure member is described. The annular member is penetrated by secondary coolant inlets and outlets. (Offic. Gaz.)

37496 SCANDINAVIAN MODEL TEST FOR DEVELOPMENT OF COMMERCIAL NUCLEAR ENERGY. Lenschow, Rolf (Norges Tekniske Hoegskole, Trondheim, Norway). Tek. Ukebl., 116: 488-91(Apr. 24, 1969). (In Norwegian).

A joint Scandinavian study on water cooled reactors has been effective for some time. Described are civil engineering aspects of a prestressed concrete pressure vessel model in scale 1:3 of a 600 MW(e) boiling water reactor. The organization and the schedule of the project are summarized. (auth) (Norway)

37497 DETECTING ACOUSTIC EMISSION IN THE PRESENCE OF NUCLEAR REACTOR HYDRAULIC NOISE. Hutton, Philip H. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 311-13(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37498 METHOD OF INHIBITING THE CORROSION OF GRAPHITE IN NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,400,508. Filed Apr. 15, 1964.

A method of inhibiting the corrosion of graphite in graphite-moderated, CO_2-cooled nuclear reactors is described. The method comprises a discontinuous treatment of the graphite during operation of the reactor so as to provide it with a protective layer by the pyrolytic decomposition of a suitable carbonaceous material, e.g., a hydrocarbon, natural gas or coal-gas. (NPO)

37499 NUCLEAR REACTORS SYSTEMS OF THE DIRECT CYCLE BOILING WATER TYPE. Dickson, George Kenneth (to United Kingdom Atomic Energy Authority). British Patent 1,155,645. June 18, 1969. Filed Nov. 9, 1966.

In conventional reactor systems of this type condensation of used steam takes place at sub-atmospheric pressures. In the system described steam generation, utilization, condensation and return to the reactor take place entirely at pressures above atmospheric, and in a chemically reducing atmosphere. A flow diagram is given for an SGHW reactor operating in this way. The initial water supply in the reactor contains a small ammonia content, the reducing atmosphere being provided by return of the initial gaseous products of radiolysis to the reactor in the steam condensate, which also reduces subsequent radiolysis to insignificant levels. This ensures that oxygen and oxides of nitrogen are not present to any significant extent, and a non-corrosive atmosphere is maintained. In an alternative arrangement hydrogen could be deliberately added to sustain the chemically reducing atmosphere. (UK)

37500 METHOD OF INHIBITING THE CORROSION OF GRAPHITE IN NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,446,411. Filed June 9, 1965.

A method of inhibiting the corrosion of graphite in graphite-moderated, CO_2-cooled nuclear reactors is presented. The method consists of the addition to the coolant of at least one chemical compound containing at least silicon and hydrogen and which is gaseous at the minimum temperature of the CO_2 in the reactor cooling loop. The chemical compound is added in a quantity of about 0.2 wt %. Numerous compounds may be used as inhibitor, SiH_4, Si_2H_4 and $Si(OC_2H_5)_4$ being preferred. (NPO)

37501 PROCESS FOR PREVENTING THE FORMATION OF DEPOSITS ON SURFACES OF A NUCLEAR REACTOR, WHICH ARE IN CONTACT WITH ORGANIC LIQUIDS. (to EURATOM). French Patent 1,498,911. Filed Nov. 8, 1966.

A process is described for preventing the formation of deposits on surfaces of a nuclear reactor which are in contact with organic liquids used as coolant and/or moderator. The process comprises treating the organic liquids with graphite powder either by filtering the liquids through a graphite bed or by suspending graphite particles in the liquids. (NPO)

37502 METHOD OF SUPPRESSING RADIOLYTIC WATER DECOMPOSITION IN NUCLEAR REACTORS. (to Atomic Energy of Canada Ltd.). French Patent 1,435,420. Filed May 18, 1965.

A method of suppressing radiolytic oxygen production in the coolant of a nuclear reactor is described. The coolant is boiling water, a mixture of water and steam, or steam. The method comprises maintaining in the coolant a concentration of ammonia in the range 3 to 20 ppM. (NPO)

Fuels

Refer also to abstracts 35007, 35270, 35400, 35402, 35561, and 36172.

37503 (CONF-690609–6) PLUTONIUM RECYCLE IN THERMAL REACTORS. Present Status of the Belgian Program. Bairiot, H.; Lhost, A. (Societe Belge pour l'Industrie Nucleaire, Brussels). Apr. 1969. 38p. (BN–6905–6). Dep.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

Work performed since 1960 in the Belgian Pu recycle program is summarized. Production and fabrication development on pellet type and vibratory compacted mixed oxide fuels is described. Experimental fuel irradiations are being conducted in the SENA and BR-3 reactors. The design of Pu recycle core configurations, the program of critical experiments, and the demonstration program in operating power reactors are discussed. (H.D.R.)

37504 (EUR-4190, pp 443-51) THE THTR PROJECT. Schulten, R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung).

The development of the THTR 300 MW(e) prototype plant is described. Detailed technical descriptions were finished in the beginning of 1968. In this nuclear power station with a high temperature He cooled reactor only ceramic materials are used in the core. Coated fuel particles designed for temperatures of 1400°C are used. The core consists of a pebble bed which allows extremely simple charge and discharge processes during full operation and therefore makes a very high exploitation of the power station possible. During power operation of the AVR-reactor, where these fuel elements were tested for the first time, this kind of nuclear fuel showed satisfactory behavior. The development programme of the THTR-Project included comprehensive investigations on the mechanical behavior of pebble beds. (auth)

37505 (EUR-4190, pp 517-34) ORDER EFFECTS IN PEBBLE BEDS. Rausch, W. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Juelich (West Germany)).

Within the development work for the AVR-Reactor, comprehensive experiments concerning the flow behavior of the fuel elements in the reactor core were carried out. As a result of these experiments it was found that the flow behavior is not stationary after the first loading with fuel elements but reaches nearly stationary state only after a considerable amount of circulated core volumes. This effect was for the first time observed in a geometry similar to the AVR-Reactor. The experimental model tests are described. The growing of ordered zones in pebble beds is demonstrated. (auth)

37506 (GEAP-5677) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Twenty-Seventh Quarterly Report, May-July 1968. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Aug. 1968. Contract AT(04-3)-189. 140p. Dep. CFSTI.

FAST CERAMIC REACTOR—fuel elements for, development during May-July 1968
—core neutronics of
—safety characteristics of
—thermal hydraulics of
FISSION PRODUCTS—release to NaK coolant from failed fuel pin
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation effects testing of Fast Ceramic Reactor fuels of
—PuO_2-UO_2, physical properties of fast reactor fuels of
—PuO_2-UO_2, mechanical properties of fast reactor fuels of
RADIATION TARGET CANS—design of forced convection capsule for defected mixed oxide fuel testing
REACTOR FUEL ELEMENTS—development of high performance mixed oxide, for Fast Ceramic Reactor
—compatibility of cladding-fuel-sodium-bonded mixed oxide
—fission product distribution and release from mixed oxide
—response of axially restrained mixed oxide, during severe transients
—cladding alloys for Fast Ceramic Reactor mixed oxide, performance characteristics of
REACTOR FUELS—relocation of molten mixed oxide, during transients
—performance of mixed oxide, in fast reactors
REACTOR SAFETY—fuel element behavior during Fast Ceramic Reactor transients
REACTOR SAFETY EXPERIMENTS—fuel pin explosive burst testing in SPERT, feasibility of
SODIUM—reactions with water, design of Soda Pop facility for testing
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation effects testing of Fast Ceramic Reactor fuels of
—PuO_2-UO_2, physical properties of fast reactor fuels of
—PuO_2-UO_2, mechanical properties of fast reactor fuels of
WATER—reactions with sodium, design of Soda Pop facility for testing (H.D.R.)

37507 (GEAP-5700) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Twenty-Eighth Quarterly Report, August-October 1968. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Nov. 1968. Contract AT(04-3)-189. 120p. Dep. CFSTI.

FAST CERAMIC REACTOR—fuel elements for, development during Aug.-Oct. 1968
—core neutronics of
—thermal hydraulics of
—safety characteristics of
FISSION PRODUCTS—release from high performance mixed oxide fuel elements
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation effects testing of fuels of
—PuO_2-UO_2, physical properties of fast reactor fuels of
REACTOR FUEL ELEMENTS—development of high performance mixed oxide, for Fast Ceramic Reactor
—cladding for mixed oxide, performance of defected
—compatibility of fuel cladding interface in contact with sodium
—fission product distribution and release from mixed oxide
—response of axially restrained mixed oxide, during severe transients
—cladding alloys for fast reactor mixed oxide, performance characteristics of
REACTOR FUELS—relocation of molten mixed oxide, during transients
—performance of mixed oxide, in fast reactors
REACTOR SAFETY—fuel element behavior during Fast Ceramic Reactor transients
STAINLESS STEEL—properties for use as fast reactor fuel cladding
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation effects testing of fuels of
—PuO_2-UO_2, physical properties of fast reactor fuels of (H.D.R.)

37508 ENGINEERING PRINCIPLES OF HIGH-TEMPERATURE REACTORS. Lockett, G. E.; Hosegood, S. B. (Atomic Energy Establishment, Dorset, Eng.). pp 155-79 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The basic concept of the high-temperature reactor, with its ceramic core and inert cooling gas, provides a system which offers many opportunities for converting reactor heat into electrical energy. Furthermore the use of coated particle fuel, with its good fission product retention behavior at elevated temperatures, ensures that radioactivity in the cooling gas will be low and that conversion cycles operating at high temperature and high efficiency can be used without the difficulties or expense of highly active circuits. There are a number of possible fuel cycles and reactor arrangements so that it becomes necessary to examine critically the issues involved and to evaluate each scheme in a developed engineering form. Several studies have been carried out in sequence on different systems, each having some advantages and some limitations but all showing very encouraging economic features. This series of studies has allowed the introduction of improved solutions in many areas of design and ideas have now evolved towards a single line of development which has the flexibility to permit a choice of fuel cycle and to allow the use of power plants with either indirect steam cycles or closed-cycle gas turbines. The reactor system in its present design form represents a successful merging of the most desirable aims in fuel development, fuel-cycle use and core design while allowing full development opportunities for power conversion from the same basic reactor. Some of the most important developments are discussed and future development possibilities are outlined. (auth)

37509 PROSPECTS FOR THE HTR WITH PRISMATIC FUEL. Smith, D. R. (Nuclear Power Group Ltd., Knutsford, Eng.); Boehm, E.; Storrer, J.; Acciari, P. pp 181-95 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The initial development program of Dragon Project was based on the Th cycle, but more recently it has been shown that the technology is equally relevant to U cycles. The ability of the HTR to use either fuel economically will become an important advantage in the widespread exploitation of nuclear power. Evidence to show how the HTR can be optimized either for Pu production or for a "throw-away" fuel cycle to suit individual customer requirements is presented. The reasons for the choice of fuel geometry and operating parameters are outlined. The first proposal for a fully commercial HTR submitted in the UK towards the end of 1967 is described. To minimize the technical risk involved in introducing a new system, this design makes maximum use of engineering features developed for early British gas-cooled reactors, in particular, a permanent cool moderator and single-channel access refueling. The only major novel features are the use of He instead of CO_2 coolant, and coated particles in place of

stainless steel clad oxide fuel. The proposed cluster of 18 annular fuel pins is described. Later HTR designs with a replaceable moderator and multi-channel access refuelling either on or off-load are presented. The limited life required from the moderator as compared to the permanent core design permits a substantial increase in power density and avoids the complex arrangements for moderator cooling. The resulting capital cost saving more than offsets the cost of replacing the moderator. The combination of the HTR with a closed-cycle He turbine offers attractive possibilities in terms of a simple thermodynamic cycle and proven turbine technology. A design is presented in which the reactor, turbine and heat exchanger plant are accommodated within a single prestressed concrete pressure vessel, offering a dramatic reduction in building volume compared to a steam-cycle plant. 5 references. (auth)

37510 GAS-COOLED FAST REACTOR WITH DIRECT-CYCLE POTENTIAL. Gratton, C. P. (United Kingdom Atomic Energy Authority, Winfrith, Eng.); Bevan, E. G.; Hooper, A. T.; Horsley, G. W. pp 359-83 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

A gas-cooled fast reactor capable of high coolant gas outlet temperatures could ultimately take advantage from the parallel development of the direct cycle. The feature of the concept which permits high outlet temperature is the use of ceramic coated-particle fuel element in which a porous particle bed is cooled by the direct flow of coolant through it. With coolant pressure similar to those of current proposed thermal HTGR designs, fissile inventories and doubling times comparable with Na reactors are achieved in a plant with good capital cost potential. The particles are based on SiC coating rather than pyrolytic C as the pressure retaining envelope, to give improved dimensional stability under fast reactor conditions and to improve corrosion resistance to coolant impurities. The use of all-ceramic fuel eases many of the safety problems, particularly under conditions of loss of coolant pressure or circulation and is an important advantage of this concept compared with other gas-cooled fast reactor concepts. The development problems for the fuel assembly are to demonstrate that the favorable fission-product retaining capability to high burn-up shown for coated particles for thermal reactors can be retained in fast reactor conditions; and to achieve the necessary flow distribution in a fuel assembly with transverse flow through a porous bed. 10 references. (auth)

37511 INFLUENCE OF HTRs ON NUCLEAR FUEL REQUIREMENTS. Haubert, P.; Debay, W. (Belgonucleaire, Brussels). pp 849-58 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The fuel requirements, fuel cost and Pu production of a power generating system with only one type of power plant and their dependence on the rate of expansion of the system are analyzed. A power generating system where different types of nuclear reactors coexist is also described. For each model of installation of the various reactor types, the optimum utilization of the Pu produced in the system is evaluated, taking into account the nuclear and economic characteristics of Pu fuels in each reactor type (in particular initial and final enrichments, burn-up, fabrication and reprocessing charges). For this policy of Pu utilization the fuel requirements and the generating cost of the system are then computed and compared for the various models of HTR installation. The interest of high-temperature reactors, especially as regards the fuel-cycle cost and the benefit accrued from Pu utilization (Pu value), is described. 5 references. (auth)

37512 LONG-TERM INVESTIGATIONS INTO THE ECONOMIC POTENTIAL AND FUEL SUPPLY OF HTRs WITH DIFFERENT FUEL CYCLES. Kraemer, H.; Markowski, B.; Wagemann, K. (Kernforschungsanlage, Juelich, Ger.). pp 831-48 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

One of the main characteristics of HTRs is great flexibility in the fuel cycle. Several different cycles can be applied from the neutronic and economic points of view and it is possible to change from one cycle to another during reactor operation. In addition to the well-known cycles—U with low enrichment and Th/U with high-enriched U—two other cycles have been investigated on the same ground rules: feed and breed Th cycle with Pu feed; Th/U cycle with 20% enriched U make-up. The results of the fuel-cycle calculations are presented. The consequences on the fuel service which arise from the different cycles in an expanding power generating system are analyzed. The cumulative U requirements and the requirements for separation work and reprocessing capacities are calculated and put in relation to the economic potential of the different cycles. A computer program by Harde and Memmert has been used for the calculations by which the capacity of a future power generating system can be divided up on several lines of power plants in such a way that the total generating costs will be kept to a minimum. LWR, fast breeders, and HTRs are considered as well as conventional plants. The investigations concern the future power grid of the Federal Republic of Germany, however the results can be converted to other systems. 6 references. (auth)

37513 ECONOMICS AND TECHNOLOGY OF HTGR FUEL RECYCLE. Lotts, A. L.; Wymer, R. G. (Oak Ridge National Lab., Tenn.). pp 789-813 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The attainment of low power cost and high fuel utilization in high-temperature gas-cooled reactors (HTGRs) using the thorium-^{233}U fuel cycle depend to a great extent upon the ability to economically recycle fuel. Accordingly, work is being conducted by the Oak Ridge National Laboratory and others to establish the technical requirements and economics for HTGR fuel recycle. The development effort, which is based on a fuel element having a pyrolytic carbon and silicon carbide coated ^{233}U–^{235}U-thorium fuel in graphite prismatic blocks, includes the development of processes and equipment for head-end processing, for chemical reprocessing, for sol-gel preparation of microspheres, and for refabrication of fuel elements. The ultimate objective is to furnish engineering data for the design and operation of a large commercial recycle. In addition, the recycle economics and the effects on economics of various alternatives in the recycle processes are being studied. The status of the recycle effort is described and recent projections of the cost of recycle HTGR fuel as well as the cost penalties associated with delay in recycling fuel in a growing HTGR economy are analyzed. At present, the various processes are in the stage of laboratory development and conceptual design of pilot-scale equipment. The status of all steps in the recycle processes is discussed and the pilot facility, the Thorium–Uranium Recycle Facility (TURF), is briefly described. TURF has been constructed and is ready for installation of equipment for HTGR recycle work. The reference fuel design and the status of the work under way, including irradiation performance tests of coated fuel particles, are also discussed. 44 references. (auth)

37514 PLUTONIUM FUELS FOR FEED-AND-BREED HTR CONCEPTS. Price, M. S. T. (Atomic Energy Establishment, Winfrith, Eng.); Bairiot, H.; Klusman, A. pp 761-73 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The state of advancement on the utilization of Pu as an HTR fuel is analyzed. A summary of previous data and of the latest results is given concerning the selected fuel design and its field of application, the fabrication trials and the irradiation test. The fabrication cost of this type of fuel is evaluated and compared to the cost of enriched U fuel. 18 references. (auth)

37515 ALTERNATE FUEL CYCLES FOR THE HTGR. Fischer, P. U.; Jaye, S.; Stewart, H. B. (Gulf General Atomic Inc., San Diego, Calif.). pp 745-60 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The block-type fuel element which Gulf General Atomic has developed for the High-Temperature Gas-Cooled Reactor (HTGR) can be adapted to the potentially important fuel cycles that involve ^{235}U, ^{233}U and ^{239}U and ^{239,241}Pu as fissile materials and ^{232}Th and ^{238}U as fertile materials. Of most immediate interest are the four cycles: ^{235}U/^{232}Th/^{233}U cycle; ^{232}Th/^{233}U recycle with ^{235}U make-up; ^{232}Th/^{233}U recycle with Pu make-up; and ^{235}U/^{238}U/^{239}Pu, i.e. the low-enrichment cycle. These four fuel cycles are compared in this evaluation. It is shown that the cycles using ^{232}Th as a fertile material promise somewhat better economics than the low-enrichment U cycle and that the margin of advantage increases with rising uranium ore costs. The use of the low-enrichment U cycle in the HTGR may offer some advantages under special conditions. The type of multilayer coated particle developed at present is expected to perform equally well with the Th and the low-enrichment U cycles. Fuel element blocks similar to those developed for the 330-MW(e) Fort St. Vrain HTGR power station can easily accommodate low-enrichment U fuel. Furthermore, it is possible to effect a transition from the Th to the low-enrichment U cycle in an operating HTGR plant without modifications in the plant design. The ^{232}Th/^{233}U recycle with Pu make-up is also receiving attention. Its attraction, of course, depends on the availability and cost of Pu fuel. On the basis of expected Pu values in other thermal-spectrum reactors, the use of Pu as a make-up fuel in the HTGR appears to be competitive with the use of ^{235}U. 5 references. (auth)

37516 FUEL CYCLES FOR THE HTR. Dickinson, N. (Nuclear Power Group Ltd., Knutsford, Eng.); Ghilardotti, G.; Haubert, P. pp 729-43 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

Fuel cycles analyzed during the development of high-temperature reactors at TNPG are described. Many variants of reactor design and associated fuel cycle are considered but all utilize enriched U as the feed material. The interaction between the choice of fuel cycle and the choice of reactor parameters is discussed. A range of fuel geometries and lattice pitches are considered and results are presented to illustrate the choice of an optimum design. Results are also given to illustrate the sensitivity to the costing assumptions and how these influence the choice of reactor parameters. These results are for the chosen fuel cycle, i.e., a just-critical initial loading with continuous on-load refuelling leading to a dual-enrichment fuel cycle at equilibrium. The subsequent sections justify the choice of such a fuel cycle. The selection of the equilibrium fuel cycle is described with particular reference to the choice of discharge irradiation and the choice between an off-load batch-fuel cycle and an on-load continuously refuelled cycle. Particular attention is given to the control of the reactor rating distribution during the equilibrium cycle. Some consideration is given to the use of radial or axial shuffling. A description is also given of the choice of the initial loading and the fuel-cycle strategy during the approach to equilibrium. Among the possibilities studied are the use of a mixed enrichment just-critical loading, burnable poisons and schemes with a reduced fuel inventory. Throughout these sections comparisons are made with the detailed fuel cycle being developed by TNPG for the Hinkley Point "B" and Hunterston "B" AGRs. 5 references. (auth)

37517 FUEL CYCLES AND REACTOR PHYSICS OF HETEROGENEOUS AND HOMOGENEOUS HIGH-TEMPERATURE REACTORS. Gutmann, H. (Atomic Energy Establishment, Winfrith, Eng.); Daub, J.; Schober, H.; Woloch, F.; Devos, J. J.; Graziani, G.; Rinaldini, C.; Zanantoni, C.; Journet, J. A. pp 705-28 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

Low-enriched uranium and high-enriched urnaium/thorium fuel cycles with continuous charge/discharge fuel management and with provision for xenon override are reviewed for both heterogeneous and homogeneous reactor designs. In this context the term heterogeneous design is used for a reactor with a fixed moderator structure with a regular lattice of fuel channels containing the replaceable fuel assemblies, while the term homogeneous design is used for a reactor in which the whole core consists of an assembly of replaceable graphite blocks which contain the fuel assemblies. In both designs there is sufficient lumping of the fuel to give appreciable resonance shielding so that both designs are heterogeneous from the reactor physics point of view. Overall and fuel temperature coefficients of reactivity are reported and some calculations on the kinetic behavior of these systems are also given. For the homogeneous designs of reactor the effect is investigated of having to depart from the ideal geometrical arrangement to one which permits the easy charge and discharge of graphite blocks containing the fuel assemblies. 12 references. (auth)

37518 FUEL DESIGN, MANUFACTURE, AND MANAGEMENT EXPERIENCE DURING THE UK NUCLEAR POWER PROGRAMME AND ITS RELEVANCE TO HTRs. Johnson, A.; Inglis, G. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 693-704 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The design parameters of the Magnox, AGR and HTR systems are compared in order to determine the effect on the fuel designer, supplier and reactor operator if the HTR is introduced into the UK Nuclear Power Programme. A comparison of the fuel cycle economics of the three systems is also shown. The effect of introducing the HTR on the UK nuclear fuel cycle is described by reference to uranium ore concentrate, separative work, fabrication and reprocessing requirements of the three systems. The effect on the fuel designer is described by comparing design criteria and the necessary development programs with reference to previous experience in proving the Magnox and AGR fuel designs. The fuel management aspects of the three designs and the effect on the operator are compared and contrasted in terms of refuelling rates, reactivity transients, macroscopic rating effects during the progress of the fuel management scheme and temperature control criteria. 5 references. (auth)

37519 FUEL AND MATERIAL TESTING FOR PEBBLE-BED REACTORS. Stoecker, H. J. (Kernforschungsanlage, Juelich, Ger.); Delle, W.; Olshausen, K. D.; Pott, G.; Ehlers, K.; Groos, E.; Valette, L. pp 681-90 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The pebble-bed reactor is a high-temperature gas-cooled reactor with the unique feature of having a downward moving core of randomly packed fuel spheres contained in a structural graphite reflector. From this configuration specific requirements result for the core materials which must be fulfilled under the temperature, burn-up and fast neutron environment of HTRs. The specification tests for the second charge of the AVR produced by NUKEM are described and show that standard production can fulfil AVR requirements. Coated particles, complete spheres and graphite irradiation tests performed for a 300-MW(e) prototype reactor are discussed. The main objective of this irradiation program was the development and testing of structural graphite and fuel elements in view of their mechanical strength, corrosion behavior and fission product retention. The results indicate that the prototype can be built with sufficient confidence in the behavior and performance of the core materials. The planned research and testing program for the optimization of the first generation of commercial pebble-bed reactors and for more advanced concepts of this type of reactor is also presented. (auth)

37520 RECENT DEVELOPMENTS IN THE MANUFACTURE OF SPHERICAL FUEL ELEMENTS FOR HIGH-TEMPERATURE REACTORS. Hackstein, K.-G. (Nukem Nuklear-Chemie und -Metallurgie GmbH, Hanau, Ger.); Hrovat, M.; Spener, G.; Ehlers, K. pp 673-9 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

A type of fuel element has been developed for the gas-cooled high-temperature pebble-bed reactor which satisfies the mechanical, thermal and nuclear requirements of a power reactor (300-MW(e) prototype). This is a "molded element" concept consisting of a 50-mm diam. inner core containing coated-particle fuel matrix graphite and of an outer fuel-free graphite shell of 5-mm thickness. The different production steps necessary for the manufacture of this kind of element are: preparation of a suitable graphite powder for molding; overcoating of the coated particles with this graphite powder; molding of the fuel element in two steps; and subsequent heat treatment. The mechanical, thermal and nuclear properties are discussed. They fulfill power reactor requirements in most relevant points. Irradiation tests on loose particles and graphite specimens as well as on complete fuel elements were satisfactory. The irradiation shrinkage of the graphite is (even at high fast-neutron doses) relatively small compared with other nuclear graphites. At a fast neutron dose of 6×10^{21} n/cm^2 the shrinkage was less than 0.5%. The R/B values of complete fuel elements during irradiation up to 10% fima burn-up at a temperature of 1200°C were less than 5×10^{-5}. Because of the encouraging results it is intended to load several thousand elements of this type into the AVR at Juelich by the beginning of 1969. The development work will, however, be continued. The main emphasis will be put on optimizing the different production steps. (auth)

37521 DESIGN AND DEVELOPMENT OF FUEL FOR THE HTR. Bairiot, H. (Belgonucleaire SA, Brussels); Thomson, J.-M.; Emsley, G. M. pp 647-72 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

Fuel elements using coated-particle fuel contained in graphite cans are proposed for HTR. The consideration of fuel particle size in relation to an economic reactor design leads to a requirement for the development of larger particle, higher density fuel than has been investigated previously. Fuel must be suitable for enrichments of 5 to 10% and irradiations of 5 to 10% FIMA. The problems associated with the selection of the UO_2 fuel kernel size and porosity, and the composition and thickness of the particle coatings to achieve satisfactory irradiation characteristics are discussed. The fuel particles are bonded together within the graphite can to limit dispersion in the event of can rupture. Development work aimed at the achievement of a satisfactory fuel, on the ground of desirable properties, fabricability and applicability to large scale production is described. The embodiment of the particle fuel into a stable, handlable and durable fuel element requires the simultaneous accommodation of several conflicting requirements. The design must accommodate the irradiation-induced dimensional changes in the fuel, can and structural components while preventing rattling or vibration of element components under the influence of the high channel-coolant flow. 15 references. (auth)

37522 FUEL ELEMENTS FOR HIGH-TEMPERATURE REACTORS: BASIC MATERIALS PHILOSOPHY OF THE DRAGON

PROGRAMME. Huddle, R. A. U. (Atomic Energy Establishment, Winfrith, Eng.). pp 631-45 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The basic philosophy on which the Dragon Project Fuel Element Development Programme has been based is described. Particular attention is directed towards the present concept of a fuel element for the homogeneous low-enriched high-temperature reactor. During the last five years considerable progress has been made in understanding the behavior of coated-particle fuel in service and the various factors affecting this behavior are discussed in some detail. A coated-particle fuel based on a porous oxide kernel of about 750 microns diameter having a complex PyC/SiC/PyC coating has given excellent results in exploratory experiments: these results are summarized. 12 references. (auth)

37523 DEVELOPMENT OF SILICON CARBIDE CLAD FUEL PINS FOR ADVANCED GAS-COOLED REACTORS. D'Eye, R. W. M. (United Kingdom Atomic Energy Authority, Salwick, Eng.). pp 617-30 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The development of an all-ceramic fuel pin was undertaken to advance the AGR gas-cooled reactor concept, for example, by allowing higher surface temperatures about 1000°C but without making any major reactor design changes. Thus the requirement was to use fuel elements comprising pins supported in a grid cooled by CO_2. The material for the fuel pin most likely to have the required properties to operate at high temperature in a CO_2 atmosphere was SiC. To ensure that the SiC would be protected from fission fragment damage, the fuel particles are coated with pyrolytic C. From this, two fuel pin concepts have emerged, namely coated fuel particles dispersed in a matrix of SiC with an outer unfuelled region of SiC, and coated particles bonded together and contained in a SiC can. The major advantages of the latter concept are that it allows higher U loadings and surface thermal stresses are lower. A fabrication route based on the method of self bonding has been developed for the fabrication of SiC bodies allowing rods and tubes to be made in quantity. The physical, mechanical and chemical properties have been determined and the effect of fast neutron damage on some of these properties assessed. The fluidized bed technique for the manufacture of coated particles to any specification has been developed using pilot-scale equipment. The coated particles used have been based on UC_2 and UO_2 kernels with pyrolytic C and SiC coats, depending on the fuel pin requirements. The coated particles are dispersed either in a matrix of SiC in the form of rods, or bonded together and contained in a SiC can. In the latter instance the bond is such as to give improved thermal conductivity and prevent spillage of coated particles to the coolant should a can fail. Both fuel pin concepts have had irradiation trials. For the rod concept with U loadings up to 1.7 g U/cm^3 the test conditions were surface temperature up to 1290°C, linear ratings up to 420 W/cm, and burn-ups to 45,000 MWd/t U. The release of gaseous and metallic fission products was low and post-irradiation examination showed no damage to the SiC matrix or outer layers of the coated particle, the damage being limited to the inner buffer coat of the coated particle. For the can concept with U loadings up to 3.0 g U/cm^3 the conditions were surface temperature up to 1000°C in 400 lb/in.^{2} CO_2, and linear ratings up to 500 W/cm. The burn-ups achieved to date are up to 25,000 MWd/t U with negligible release of fission products. 18 references. (auth)

37524 INTERNATIONAL ASPECTS ON NUCLEAR ENERGY FOR ELECTRIC POWER PRODUCTION. Eklund, Sigvard (International Atomic Energy Agency, Vienna). Tek. Tidskr., 99: 491-4(1969). (In Swedish).

A review is made of the use of nuclear energy for production of electricity. Topics discussed are: uranium resources, pricing pattern for U_3O_8 enrichment, fuel element fabrication, and reprocessing of spent fuel. (Sweden)

37525 IN-PILE MEASUREMENTS OF THERMAL EXPANSION OF UNIRRADIATED EBR-II DRIVER FUEL. Rothman, A. B.; Renken, C. J.; Stewart, R. R.; Dickerman, C. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 349-50(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37526 CORRELATION OF BURNUP AND CLAD DAMAGE FOR FAST REACTOR FUEL DEVELOPMENT. Dahl, R. E. Jr. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 139-40(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37527 FISSION PRODUCT RELEASE FROM AN ENCAPSULATED U-Pu-Zr TERNARY ALLOY FUEL ELEMENT. Smith, R. R.; Ebersole, E. R.; Fryer, R. M.; Henault, P. B. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 180(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37528 CYGRO-1 ANALYSIS OF FAST BREEDER REACTOR FUEL DESIGN. Tripp, L. E.; Scarborough, J. C. (Nuclear Utility Services, Rockville, Md.). Trans. Amer. Nucl. Soc., 12: 109-11(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37529 IDENTIFICATION OF FAILED FUEL ELEMENTS BY XENON TAG. Henault, P. B. (Argonne National Lab., Idaho Falls, Idaho); Bernstein, G. J.; Coleman, L. F.; Ebersole, E. R.; Larson, W. J.; Smith, R. R. Trans. Amer. Nucl. Soc., 12: 102-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37530 MODELING STUDIES OF METALLIC FUEL; WITH APPLICATION TO EBR-II DRIVER FUEL ELEMENTS. Walter, C. M.; Jankus, V. Z. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 90-1(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37531 PERFORMANCE OF EBR-II DRIVER FUEL. Bacca, J. P. (Argonne National Lab., Idaho Falls, Idaho); Foote, F. G.; McClellan, G. C.; Cook, J. H. Trans. Amer. Nucl. Soc., 12: 90 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37532 PRODUCTION COSTS FOR ^{238}Pu IN A PRESSURIZED WATER REACTOR. Merrill, E. T.; Nunn, S. E.; Heeb, C. M.; McKee, R. W. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 40(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37533 THE PROSPECTS FOR ADVANCED CONVERTER LWR'S BASED ON URANIUM METAL FUEL. Anderson, Truman D.; Jones, J. E. Jr.; Podeweltz, C. M.; Welfare, F. G. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 36-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37534 PRESENT STATUS OF THE BELGIAN PROGRAM ON PLUTONIUM RECYCLE ON WATER-COOLED REACTORS. Bairiot, H. (Societe Belge pour Industrie Nucleaire S. A., Brussels). Trans. Amer. Nucl. Soc., 12: 35-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37535 ^{233}U-BEARING SALT PREPARATION FOR THE MOLTEN SALT REACTOR EXPERIMENT. Chandler, J. M.; Bolt, S. E. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 25-6(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37536 SEFOR CORE CLAMPING SYSTEM. Hansen, Ned P. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 321-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37537 USE OF 240-ENRICHED PLUTONIUM AS A FAST REACTOR FUEL. Connolly, T. J.; Goodrich, J. M. (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 12: 273-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37538 SPECIAL APPLICATIONS OF PLUTONIUM IN POWER REACTORS. Lanning, D. D.; Busselman, G. J. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 233(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37539 DEMONSTRATION PROGRAM OF PLUTONIUM RECYCLE IN A BOILING WATER REACTOR. Tomonto, James R. (United Nuclear Corp., Elmsford, N. Y.); Tulenko, James S.; Veras, A. Trans. Amer. Nucl. Soc., 12: 232(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37540 NUCLEAR AND FAST TRANSIENT ASPECTS OF PLUTONIUM PARTICLE SIZE IN THERMAL RECYCLE FUEL. Aitken, E. A. (General Electric Co., San Jose, Calif.); Fischer, D. L.; Friis, R. W.; Lanning, D. D.; Vaughn, A. D.; Freshley, Max; Miller, R. W.; Johnson, R. L.; Robkin, M. A. Trans. Amer. Nucl. Soc., 12: 229-30(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37541 IN-CORE STUDY OF DIMENSIONAL BEHAVIOR OF UO_2 FUEL RODS. Kjaerheim, G.; Rolstad, E. (OECD Halden Reactor Project, Norway). Trans. Amer. Nucl. Soc., 12: 205-6 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37542 THE BEHAVIOR OF METALLIC-URANIUM TUBULAR FUEL ELEMENTS DURING HIGH-TEMPERATURE IRRADIATION. Guay, Arthur E. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 203(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37543 IRRADIATION BEHAVIOR OF ZIRCALOY-2-CLAD THORIUM–URANIUM ALLOY FUEL ELEMENTS. Goffard, J. W.; Marshall, R. K. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 203-4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37544 SYMPTOMS ASSOCIATED WITH A LOSS-OF-BOND-TYPE DEFECT IN AN EBR-II DRIVER ELEMENT. Fryer, R. M.; Ebersole, E. R.; Henault, P. B.; Smith, R. R. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 179-80(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37545 HEAT TRANSFER FROM AN ALUMINUM/URANIUM FUEL PLATE IN A SUBCOOLED POOL DURING A TREAT TRANSIENT. Harrison, Lawrence J. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 346-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37546 POWER BURSTS IN ZIRCALOY-2-CLAD UO_2 FUEL RODS. Miller, R. W.; Lussie, W. G. (Phillips Petroleum Co., AED, Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 344-6 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37547 NUCLEAR REACTOR FUEL BURST CAN DETECTION SYSTEM. Bagneux, M. G.; LeMeur, R.; Antony, A. R. (to Commissariat a l'Energie Atomique). Canadian Patent 808,350. Mar. 11, 1969. Priority date May 13, 1964, France.

A method for locating failed fuel in a gas cooled reactor is described. The fuel channels are grouped in sub-assemblies and in assemblies connected to a scanning circuit which includes a detection unit having a delayed-neutron detector and an electrostatic collection detector. Also there is a "burst follower circuit" having a detector unit which successively scans each sub-assembly. When the activity detected by all of these solid fission product detectors simultaneously exceeds a predetermined threshold, this sub-assembly is isolated from among those simultaneously analyzed which has an activity in excess of the mean value of sub-assembly activities. After this step the delayed neutron detector of the sub-assembly is connected to determine whether the activity passes another predetermined threshold and if so this sub-assembly is connected to the burst follower detector for identification of the channel. (F.S.A.)

37548 Xe RELEASE FROM UO_2 UPON OXIDATION. Ikawa, Katsuichi; Taketani, Kiyoaki (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol., 6: 346-7(June 1969).

Studies were made on Xe release from UO_2 upon oxidation by O_2 at 600 to ~1,300°C. It was confirmed that fission gas release from UO_2 in a burning accident should be limited to 20%, irrespective of burning temperature and that there should be no appreciable difference between air and 0_2 atmosphere. If the environmental temperature stays high, however, fission gas will continue to be released by diffusion through the higher oxide formed by oxidation. A small and rather complicated temperature dependence noted suggests that the release during oxidation is primarily due to liberation upon pulverization by oxidation instead of diffusion. (P.C.H.)

37549 MARKETING AND MANUFACTURING NUCLEAR FUEL. Toye, J. M. (Canadian Westinghouse Co., Ltd., Hamilton, Ont.). Can. Mining Met. Bull., 62: 614-15(June 1969).

The Canadian nuclear fuel business relates primarily to supplying fuel for Candu reactors. The product development, manufacturing and marketing activities of the nuclear fuel industry will therefore be determined by the rate of growth of the Candu nuclear reactor business. The nature of this relationship between the Canadian nuclear fuel industry and the Canadian Heavy Water Reactor program is considered, with particular reference to the factors influencing future economic growth. (auth) (Canada)

37550 ANNULAR NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,499,999. Filed May 27, 1966.

An annular fuel element for use in graphite-moderated CO_2-cooled nuclear reactors is described which consists of a tubular fuel body provided with an inner and an outer sheath. The sheaths are interconnected by annular end-plugs and are provided with cooling fins arranged in a chevron-pattern. The outer sheath and the end-plugs consist of a Mg-alloy, preferably a Mg–Zr alloy having a low Zr content, e.g., 0.4 wt %, the inner sheath being composed of an alloy, e.g., Zircaloy having a low neutron absorption cross-section and a heat resistance exceeding that of said Mg-alloy. Preferably the inner sheath consists of ATR (a Zr-alloy containing 0.5 wt % of Cu and 0.5 wt % of Mo) or TJR (a Zr-alloy containing 1 wt % of Cu and 1.5 wt % of Mo). The alloys have a high corrosion resistance with respect to CO_2. (NPO)

37551 GAS-COOLED NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,471,115. Filed Mar. 14, 1966.

A gas-cooled nuclear reactor is described, wherein at least some of the surfaces in contact with the coolant, e.g., the sheaths of the fuel elements, are of Ni or a Ni–Cu alloy. The coolant consists of CO_2 and a quantity of CO to reduce the oxygen potential of the coolant. The concentration of the CO is in the range 1.3 to 5.0 vol. %. Preferably the fuel element sheaths consist of a Ni–Cu alloy containing at least 70 wt % of Ni or are composed of Ni having an oxide dispersion therein. (NPO)

Auxiliary and Emergency Systems

Refer to abstract 35565.

Operation and Economics

Refer also to abstract 37423.

37552 (WASH-1087) AN EVALUATION OF ADVANCED CONVERTER REACTORS. (Advanced Converter Task Force). Apr. 1969. 139p. GPO $1.50.

The objectives and scope of study for an evaluation of advanced converter reactors are given. The concepts which are evaluated are described. Performance characteristics, economic evaluation, and fuel utilization characteristics are given for each of the concepts. The ground rules and cost basis for economic evaluation are defined. Technical evaluations of the concepts are detailed. Capital, fuel-cycle, operation and maintenance, and power costs are analyzed. The research and development programs for the heavy water-moderated organic-cooled reactor (HWOCR), the heavy water-moderated boiling light water-cooled reactor (HWBLW), and high temperature gas-cooled reactor (HTGR) concepts are discussed. 32 references. (M.L.S.)

37553 OPERATIONAL CHARACTERISTICS OF GAS-COOLED REACTORS FUELED WITH COATED PARTICLES. Cave, L.; Carstairs, R. L.; Nichols, R. W. (Atomic Power Constructions Ltd., Surrey, Eng.). pp 223-43 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

A review is presented of those characteristics, other than cost, of the He-cooled reactor with coated-particle fuel which are of importance to the purchaser in relation to the use of the reactor in his electricity supply network. Where appropriate, these characteristics are also compared with those of other power reactor systems currently available. The extent to which this comparison depends upon the outcome of development work on fuel and other components, where this is still in progress, is discussed. The review includes a consideration of the following: suitability for urban siting, both in terms of normal operation and fault behavior; operational flexibility, including suitability for part load operation,

for frequency correction and for use as spinning reserve, and ability to withstand transient conditions; reliability, showing the relation of previous operating experience with gas-cooled reactors to the assessment of reliability of the types now proposed; availability, including the relation of previous experience to the assessment of outages and the effect of fuel cycles and fuel management on availability. It is concluded that the availability and the reliability obtained with current gas-cooled reactor designs will be maintained with types of higher rating. The operational flexibility should be more than adequate for the conditions pertaining to the electrical systems in most countries with a high degree of industrial development. Subject to the successful outcome of present test work on coated-particle fuel these reactors should be among the most suitable for urban siting. 7 references. (auth)

37554 OPERATIONAL EXPERIENCE WITH THE AVR REACTOR. Cautius, W.; Hantke, H. J.; Ivens, G.; Schweiger, F. (Arbeitsgemeinschaft Versuchsreaktor AVR GmbH, Duesseldorf, Ger. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). pp 37-50 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

Following a short description of the AVR experimental nuclear power station, the start-up program is described. This began in July 1966 with the loading of the first fuel elements. Measurements made during the start-up program and operational experience gained thus far are presented. The most important nuclear parameters measured are presented in tables. The measured and calculated values were found to be in good agreement. Experiments and test results are described in which the following abnormal operating conditions were simulated: the sticking of a shut-down rod; the failure of the main coolant circulators; and the break-down of the main feedwater pump. Diagrams are presented which show the dynamic behavior of the system under these conditions. The experiments demonstrated that the reactor is easily controllable and can be regarded as very safe. The coolant gas radioactivity arises in all probability from uranium contamination of the fuel elements incurred during their manufacture. Attention is drawn to the fact that the core structural material includes several hundred tons of carbon stone—a non-graphitized carbon material. During heating, this material emits large amounts of water, carbon dioxide and carbon monoxide. These gaseous impurities are removed in successive stages by means of the gas-purification plant. With respect to the leak tightness of the system, helium losses corresponding to about one complete inventory per year are expected. Because of the limited operational experience gained thus far, a definitive conclusion cannot yet be made concerning the plant availability factor. In the power plant operation to date, the plant availability has been limited only by the failure of conventional components. Operational behavior is reported for such components as: the diaphragm compressors; the gas-purification plant; the fuel-handling facility; and the shut-down rod equipment. It is shown that the main requirements placed upon a power station by an electrical utility such as plant safety, operational reliability and ease of control are fulfilled. (auth)

37555 OPERATING EXPERIENCE WITH THE DRAGON REACTOR. Gray, P. S.; Watts, C. (Atomic Energy Establishment, Dorset, Eng.). pp 3-19 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The operating history of the Dragon Reactor Experiment over the first three years of power operation is outlined with special reference to the availability of the reactor. The general behavior of the core and primary circuit in terms of fission-product release and chemical purity is dealt with and the first and second charge is compared. Reference is made to experimental measurements of release made on individual fuel elements during operation and to impurity injection experiments. Figures are given for He utilization throughout the period of operation and the procedures used in controlling helium losses are described. Plant reliability is examined with special reference to those items of particular interest in HTR technology such as the He purification, charge machine, gas bearing circulators and other mechanisms operating in the primary circuit atmosphere. Experience obtained in maintaining and replacing large primary circuit components such as circulators and heat exchangers is described. Contamination levels of primary circuit items are quoted together with the methods used for activity control. The development of these methods is traced from glove-box type maintenance to simplified bagging techniques. 10 references. (auth)

37556 MARVIKEN: RESEARCH AND DEVELOPMENT. Blomberg, P. E. (Aktiebolaget Atomenergi, Sweden). Nucl. Eng. Int., 14: 568-9(July 1969).

An outline is given of the proposed boiling heavy water reactor research and development program to be carried out on the Marviken power demonstration plant. (auth) (UK)

37557 STAFFING AND STANDARDS IN PREPARATION FOR NUCLEAR POWER STATION OPERATION IN DEVELOPING COUNTRIES. Taecker, Rollin G. (Argonne National Lab., Ill.); Liu, Pei-chung. Trans. Amer. Nucl. Soc., 12: 15(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Safety and Siting

Refer also to abstract 35167.

37558 (NP-17851, pp 15-24) OVERVIEW OF REACTOR ACCIDENTS. Hejj, Attila (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In Hungarian).

A nuclear accident is defined as an event involving the uncontrolled release of radiation or of radioactive materials, resulting in a clear danger to persons in the form of external or internal exposure or in the contamination of the environment. Reactor accidents may be caused by criticality, reactor runaway, break in the fuel element cladding, corrosion of the containment vessel and of the primary circuit, contamination by the coolant, contamination of the reactor and its building by reactor experiments, and exposure of the operators. The available statistics reveal that there were 71 reactor accidents during the 1945 to 1961 period, although some minor events may have been omitted. However, because of its consequences, it is difficult to keep a major reactor accident secret. It is of interest to note that of the 5 criticality accidents, 4 occurred at the same general reactor testing station, at Arco, Idaho. The surroundings were contaminated more or less seriously at Arco in 1961, Hanford in 1955, Marcoule in 1956 and Windscale in 1957. (TTT)

37559 (NP-17851, pp 25-72) SAFETY PROBLEMS IN REACTOR CONTROL. Pallagi, Dezso (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In Hungarian).

The so-called "internal safety" of reactors is examined. It refers to the safe operation of the reactor itself, neglecting consideration of potential hazards to personnel, the population, the integrity of the fuel cladding and the core vessel. The design parameters considered included the inherent safety of the core and external control features. The negative temperature coefficient is the basis of the inherent safety. The most important factors involved are: volume expansion of the fuel element, increase of the temperature of the moderator; steam generation; Doppler effect; radiolytic gas generation and reflection of delayed neutrons. The effeciency of safety rods, burnable poisons, absorbers, and explosively triggered shutdown mechanisms is analyzed. The external control system cannot be eliminated; its design must take into account the level of runaway characteristics. The human factor also plays an important role, although there are contradictory opinions in the literature about the role of the human operator in a completely automated system. The characteristics of the control instrumentation are analyzed. (TTT)

37560 (NP-17851, pp 127-62) RADIATION PROTECTION. Toth, Mihaly (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In Hungarian).

The purpose of the shield and the biological protection system is to reduce the external γ and neutron radiation to the permissible level; this requires an attenuation of the radiation by a factor of 10^9 to 10^{11}. Structural and cost consideration must also be taken into account. The dosimetric control of nuclear power plants require measurement of the external dose, determination of the atmospheric and surface contamination, control of the operations and personnel dosimetry. The presence of the large number of fuel elements increases the probability of breaks in the cladding, followed by a release of the activity. Immediate detection of the location of faulty elements is very important for both radiation protection and economic operation. The safety of the personnel is ensured by both technical and administrative measures. Film dosimeters are widely used for protecting the personnel. Methods are available for measuring the dose to which victims of nuclear accidents have been exposed, e.g., Au foils, P and S tablets, or activation of the S in the hair. The air velocity in critical locations must be monitored. There are several methods available for detecting fuel element leakage, corrosion effects, and breakdowns in general. Attention must be paid to the safe removal of radioactive waste products. (TTT)

37561 (NP-17851, pp 177-209) INTERNATIONAL AND NATIONAL INSTRUCTIONS, AGREEMENTS, AND STANDARDS. Nyerges, Pal (Villamosenergiaipari Kutato Intezet, Budapest (Hungary)). (In Hungarian).

Since the end of World War II several multilateral international agreements on the field of atomic energy have been signed by a number of countries. The first one, signed on November 1945 in Washington by the United States, United Kingdon and Canada, mentioned the peaceful applications of atomic energy. During 1952/53, several European countries established a research laboratory in Geneva, Switzerland for the study of cosmic radiation, high-energy particle physics and theoretical nuclear physics. A similar international research center was created by Eastern countries in 1956 at Dubna, USSR. In the same year, the International Atomic Energy Agency was established. In 1959, six western European countries created Euratom. Later that year, the Security Control Convention was signed by a number of countries. This was followed by the establishment of Eurochemic and the compact on the DRAGON high-temperature, gas-cooled reactor. Since that period conferences have been held on the civil responsibility for damages due to nuclear accidents. The IAEA held many symposia on the transportation and handling of special nuclear materials, isotopes, decontamination measures, health physics regulations, etc. Disposal of radioactive wastes has been considered by panels of experts. The International Commission for Radiological Protection is involved in the establishment of health-physics standards. The Third Geneva Conference and Vienna meetings reviewed these problems. The International Standarization Organization has 4 committees on nuclear energy. (TTT)

37562 (NYO-841-18) REVIEW OF THE PROBABLE CHARACTERISTICS OF AEROSOLS RESULTING FROM ACCIDENTAL LOSS OF SODIUM COOLANT. Reist, Parker C. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.). May 1969. Contract AT(30-1)-841. 50p. Dep. CFSTI.

The mechanisms by which aerosols are generated following an accident in a sodium cooled LMFBR and variations of aerosol characteristics with time and nature of the accident are examined. The results of the study are applied to a specific example accident case for the Fast Flux Test Facility. 24 references. (H.D.R.)

37563 (RD/B/N-1285) A METHOD OF ANALYSING S.G.H.W. DRY-OUT MARGINS. Lyall, H. G.; Wright, J. K.; Young, J. D. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1969. 7p. Dep.

The method described is based on a compromise between the economic consequences of dry-out and the cost of protection against it. A physical model is presented and an illustrative numerical example is given. (UK)

37564 DESIGNING GAS-COOLED REACTORS FOR SEISMIC CONDITIONS. Dent, K. H.; Davidson, I. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 469-84 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008

Designs of graphite-gas reactors in prestressed concrete vessels have been examined for the widely differing earthquake requirements of various countries. This reactor type has been found to be well fitted to withstand seismic disturbances and even gross earth displacements such as are met with close to a fault. The whole nuclear plant is normally designed to allow continued operation during the maximum level of disturbance that is likely to occur, which depends upon the seismicity of the district and on the site geological conditions. Seismic trips are provided which can be set to shut down the reactor at an excessive level. Those nuclear plant items essential to district safety are, however, designed to survive a disturbance several times greater than the maximum that is likely to occur. In an advanced gas-cooled reactor these essential items are principally those which provide the ability to shut the reactor down and to maintain cooling; they include the reactor vessel and internal gas circuit, shut-down system, fuel, core coolant circulators, boilers, feed pumps and essential electric supplies. Static analysis gives a useful indication of the ability of some components to resist the seismic forces but dynamic analysis is essential for most items. The dominant structural element of the reactor unit is the prestressed concrete vessel. It provides a strong rigid structure to which the major reactor components can be tied, and analysis shows that the imposed stresses in the vessel are small even up to very high seismic levels, but attention has to be paid to vertical and shear loadings between vessel and foundations. The normal graphite core of the AGR requires only minor modification to meet the seismic requirement. The major internal steel components such as core support, gas baffles and boiler casings can be supported against lateral seismic loading by keys without interfering with freedom for thermal expansion. The tall fuelling machine on the top of the reactor requires only minor safeguards under conditions of low seismicity, but at high levels a damped suspension that would substantially isolate the machine from the vessel oscillations becomes desirable. 7 references. (auth)

37565 SAFETY OF THE HTR. Yellowlees, J. M. (Nuclear Power Group Ltd., Knutsford, Eng.); Scheider, R. pp 449-68 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

HTR fuel elements made of coated-fuel particles in graphite containers retain fission products satisfactorily at transient temperatures well above those calculated in fault analyses. The fuel particles are unaffected by loss of coolant-gas pressure and can be cooled safely in emergency by radiation heat transfer to the graphite moderator following temporary loss of forced cooling. The reactor has a stabilizing negative coefficient of reactivity which assists short-term control. The fuel-particle temperatures during faults can be predicted with confidence using established computing methods and the coolant cannot change its state and introduce uncertainties. In loss of coolant accidents the temperatures of immediate importance are actually those of the gas and of the fuel graphite. The gas temperature, if too high, may damage components within the pressure circuit; the hot graphite is sensitive to attack by air and also by steam (in the case of the HTR with steam turbines). Methods of controlling temperatures and coolant contamination do not differ in principle from those that have been developed for other gas-cooled reactors, Magnox and AGR. Features are applied to the steel penetrations of the prestressed concrete pressure vessel so that if coolant is lost accidentally, this occurs at a rate giving time to cool the system adequately. The general characteristics of the HTR are discussed. The effects of possible fault conditions on the retention of fission products within the pressure vessel are analyzed. The safeguards for an HTR with steam or gas turbines are described and their importance to safety is discussed. 10 references. (auth)

37566 MAJOR SAFETY ASPECTS FOR THE CONSTRUCTION OF HTGBs AND AGRs IN MORE DENSELY POPULATED AREAS. Lindackers, K.-H.; Stoebel, W.; Tscherner, M. (Technischer Ueberwachungs-Verein Rheinland eV, Cologne). pp 433-48 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The gas-cooled nuclear power plants which have been developed so far have generally been erected or operated in areas of relatively low population density and favorable meteorological conditions and topographical features influencing the spread of radioactive contamination. This applies for the reactor types developed in Britain (Calder Hall, Dragon, AGR Windscale, Dungeness "B"), for the American projects (Peach Bottom) and essentially also for the German developments (AVR Jülich, Geesthacht-II). In the recent past economic considerations led to the trend to become independent of population density, meteorological conditions and topographical features which had so far played a dominant role in site selection. On the basis of operating experience of gas-cooled experimental reactors and of conceptual power-plant designs the necessary minimum engineering conditions which, if met, will permit gas-cooled nuclear power plants with larger outputs to be designed regardless of the site are described. Considering a site which in respect to population density, meteorology and topology is extremely unfavorable, means of ensuring sufficient environmental protection during normal operation and under accident conditions will be discussed. 14 references. (auth)

37567 APPLICATION OF GAS-COOLED REACTORS TO URBAN SITES. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 423-31 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The need for objective safety criteria is analyzed, with specific reference to high-temperature gas-cooled reactors. Only marginal differences in system types are now forecast in costs; major differences can exist in risk, and it is increasingly important to foresee the need for simplicity and reliability in the future widespread application of reactors to the world markets. There is an obvious relationship between reactor safety criteria and siting. The need for progressive freedom in siting dictates above all a corresponding need to minimize the risk of major rather than minor accidents. This scheme is developed from an examination of risk criteria as determined by sites and is followed by an examination of some implications on the design of future reactors. (auth)

37568 DYNAMIC SAFETY OF PLUTONIUM RECYCLE ELEMENTS. Tulenko, James S. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 12: 347-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37569 REACTIVITY TRANSIENTS LEADING TO DISASSEMBLY IN OXIDE-FUELED FAST REACTORS. MacFarlane, D. R.; McNeal, N. A.; Heames, T. J.; Sha, W. T.; Youngdahl, C. K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 342-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37570 TRANSIENT PERFORMANCE OF MIXED-OXIDE POWDER FUEL WITH UP TO 60 PERCENT MELTING. Thomas, Garry R.; Field, John H. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 343-4 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37571 VISUAL STUDIES OF EMERGENCY-CORE-COOLING HEAT TRANSFER AND FLUID FLOW. Jensen, R. T. (Phillips Petroleum Co., AED, Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 351 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37572 CONDITIONS FOR COOLING A LARGE CRUMBLED REACTOR CORE. Wooton, Roger O.; Ray, Joseph W. (Battelle Columbus Labs., Ohio). Trans. Amer. Nucl. Soc., 12: 351-2 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37573 BOTTOM FLOODING HEAT-TRANSFER RESULTS FROM SINGLE ROD TESTS. Farman, R. F.; Leyse, R. H.; Dominicis, D. P.; Cermak, J. O. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 352-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37574 APPLICATION OF THE ECCSA-4 AND MUCHA COMPUTER CODES TO EMERGENCY-CORE-COOLING ANALYSES. Cybulskis, P.; Carbiener, W. A.; Holmes, R. E.; Cudnik, R. A. (Battelle Columbus Labs., Ohio). Trans. Amer. Nucl. Soc., 12: 353 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37575 BLODWN-2: WESTINGHOUSE APD COMPUTER PROGRAM FOR CALCULATION OF FLUID PRESSURE, FLOW, AND DENSITY TRANSIENTS DURING A LOSS-OF-FLOW ACCIDENT. Fabic, S. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 358 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37576 SUBCOOLED-BLOWDOWN: LOFT-QUARTER-SCALE EXPERIMENTAL PRESSURES AND CALCULATED TRANSIENTS USING THE WHAM-CODE. Hanson, George H. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 359-60 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37577 EXPERIMENTAL DETERMINATION OF BLOWDOWN-INDUCED STRAINS IN A SIMULATED PWR PRIMARY COOLANT SYSTEM. Heiselmann, H. W. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 360-1 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37578 SIMILITUDE CONSIDERATIONS FOR MODELING NUCLEAR REACTOR BLOWDOWNS. Carbiener, W. A.; Cudnik, R. A. (Battelle Columbus Labs., Ohio). Trans. Amer. Nucl. Soc., 12: 361 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37579 DECOMPRESSION PHENOMENA IN A SIMULATED REACTOR SYSTEM. Curet, H. D. (Phillips Petroleum Co., AED, Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 362 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37580 PRESSURE-TEMPERATURE RESPONSE OF PWR CONTAINMENTS: A PARAMETRIC ANALYSIS. Slaughterbeck, D. C. (Phillips Petroleum Co., AED, Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 362-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37581 SIMPLIFIED MODEL FOR SODIUM COOLANT EXPULSION AND REENTRY. Cronenberg III, A. W. (Northwestern Univ., Evanston, Ill.); Fauske, H. K.; Bankoff, S. G. Trans. Amer. Nucl. Soc., 12: 364 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37582 DECONTAMINATION OF WATER-COOLED NUCLEAR REACTORS: STATUS AND FUTURE RESEARCH. Ayres, J. A. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 72-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37583 ANALYTICAL MODELING OF PRESSURE-SUPPRESSION SYSTEMS. Stanford, L. E.; Webster, C. C. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 164-5 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37584 EXPOSED-FUEL CALIBRATION STUDIES IN EBR-II. Smith, R. R.; Doe, C. B.; Ebersole, E. R. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 179 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37585 AN ANALYTICAL DESCRIPTION OF OXYGEN DISSOLUTION INTO ZIRCALOY CLADDING DURING A LOSS-OF-COOLANT ACCIDENT. Krakowski, R. A. (Ohio State Univ., Columbus); Morrison, D. L.; Ritzman, R. L. Trans. Amer. Nucl. Soc., 12: 346 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37586 UNCERTAINTY ASSOCIATED WITH FISSION PRODUCT DECAY-HEAT CALCULATIONS. Bunch, W. L.; O'Dell, L. D. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 334-5 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37587 ANALYSIS OF GAS-RELEASE EFFECT IN FUEL CLADDING FAILURE. Hori, M.; Friedland, A. J. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 12: 333-4 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37588 AN ESTIMATE OF THE ENHANCEMENT OF FISSION PRODUCT RELEASE FROM MOLTEN FUEL BY THERMALLY INDUCED INTERNAL CIRCULATION. Fontana, M. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 331-2 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37589 LARGE-SCALE SODIUM AEROSOL EXPERIMENTS. Koontz, R. L.; Nelson, C. T.; Baurmash, L.; Johnson, R. P. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 331 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37590 COMPUTER CODE RIBD. Gumprecht, R. O. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 141-2 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37591 PROBABILISTIC ASSESSMENT OF RISK FOR REACTOR DESIGN AND SITING. Wall, Ian B. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 12: 169 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37592 A STUDY OF THE ADEQUACY OF SEVERAL POINT KINETICS SCHEMES FOR THE ANALYSIS OF ROD-EJECTION ACCIDENTS. Yasinsky, J. B. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 234 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37593 FILTER EFFICIENCIES OF COMMERCIAL MEDIA TO REACTOR ACCIDENT AEROSOLS. Truitt, J.; Davis, R. J.; Gill, J. S. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 330 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37594 EFFECTS OF NATURAL CONVECTION ON REMOVAL OF FISSION PRODUCTS FROM STEAM-AIR MIXTURES. Oezisik, M. Necati; Hughes, Daniel (North Carolina State Coll., Raleigh). Trans. Amer. Nucl. Soc., 12: 328-30(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37595 EVALUATION OF VARIOUS METHODS OF FISSION PRODUCT AEROSOL SIMULATION. Roberts, B. F.; Freid, S. H.; Parker, G. W.; Parsly, L. F.; Row, T. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 326(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37596 THERMAL REACTOR SAFETY. Stratton, W. R. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 11(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37597 FAST REACTOR SAFETY STATUS AND PROBLEMS. Fischer, G. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 11(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37598 REACTOR SITING AND CONTAINMENT. Thompson, Theos J. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 11-12(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37599 NUCLEAR SAFETY INFORMATION CENTER. Buchanan, J. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 13(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37600 REMOVAL OF AIRBORNE FISSION PRODUCTS BY CONTAINMENT SPRAYS. Rogers, G. J.; Coleman, L. F.; Hilliard, R. K.; McCormack, J. D. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 327-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37601 NUCLEAR CONTAINMENT. Olds, F. C. Power Eng., 73: 30-3(July 1969).

Papers presented by panelists in a seminar on containment systems for nuclear reactors are summarized. The panelists included regulators, designers, constructors, suppliers and owners of reactor facilities. The state-of-the-art of containment evolution is discussed, especially in relation to the need for codes and standards. (H.D.R.)

Power Conversion Systems

37602 BUREAU OF MINES PROGRAM FOR DEVELOPING THE CLOSED-CYCLE GAS TURBINE. Coates, N. H.; McGee, J. P.; Eckerd, J. W. (Morgantown Coal Research Center, W. Va.). pp 317-29 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

A turbocompressor equipped with hydrodynamic gas-lubricated bearings and designed for N_2 at 1.86 lb/sec, inlet temperature of 1300°F, and inlet pressure of 30 lb/in.^{2} abs. performed successfully over a wide range of conditions. Predicted performance of gas-lubricated journal bearings on the turbocompressor was equalled or exceeded throughout the test series, but satisfactory operation of a thrust bearing was not achieved. In other experiments, a 60,000 rev/min turbine designed for Ar at an inlet temperature of 1950°F, inlet pressure of 115 lb/in.^{2} abs., and exhaust pressure of 15 lb/in.^{2} abs. was operated continuously for 100 hours at about 1600°F. Hydrostatic rotor and journal bearings operated satisfactorily, only negligible dimensional changes occurring. Estimates of several conceptual coal-fired, closed-cycle turbine systems for on-site power generation in 1 to 100 MW range revealed the lowest cost at about 6 to 7 mils/kWh, a power cost that is not economically attractive in the United States. (auth)

37603 SOME CONSIDERATIONS AFFECTING THE INTEGRATION OF GAS TURBINES WITH DIRECT-CYCLE GAS-COOLED REACTORS. Hurst, J. N. (Rolls-Royce Ltd., Coventry, Eng.). pp 305-15 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

Developments in gas-cooled reactors leading to high-temperature operation are bringing close the day when direct-cycle gas turbines can be offered as economical and competitive systems. Rolls-Royce has investigated the use of turbo machinery suitable for incorporation with gas-cooled reactors, and one approach to the problem is described. The achievement of an economical operable power plant requires a close integration of turbo machinery and reactor, with a proper appreciation and coordination of the particular features of both. Those features particular to the gas turbine which will have a bearing on the performance of the reactor are discussed, and some criteria which may be imposed on the gas turbine when used with a nuclear reactor are investigated. 5 references. (auth)

37604 NUCLEAR GAS TURBINE CONCEPTS. Thorn, J. D.; Prince, K.; Coast, G. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 295-304 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The operating conditions at present envisaged for advanced types of gas-cooled reactors are such as to make the closed-cycle gas-turbine system an attractive competitor with the conventional steam-turbine plant. Two reactor coolants, He and CO_2, are available at present and both offer possibilities for an economic reactor/turbine system. Thermodynamic cycles have been evolved for both systems and the characteristics of plants based on the use of these coolants are discussed. The engineering and operational requirements of the plants are discussed and on the basis of the arguments put forward, a typical 750-MW(e) reactor layout is shown based on its appropriate operating cycle. The characteristics of the rotating machinery and the requirements of the heat exchange equipment are compared. The essential differences between the various units are discussed and the major problems indicated. The part-load behavior and accidental depressurization of the system are also briefly considered. The question of development requirements is considered and, although some are seen to be common to both systems, each is characterized by its own individual and special problems. 3 references. (auth)

37605 GAS-COOLED REACTORS WITH GAS TURBINES USING HELIUM, NEON, OR CARBON DIOXIDE. Dibelius, G. (Technische Hochschule, Aachen); Foerster, S.; Heil, J.; Schneider, K. U. pp 247-70 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

Gas-turbine cycles and their components for various types of gas-cooled reactors using different gases are compared. The Advanced Gas-Cooled Reactor, the high-temperature reactor and the fast reactor are considered, and He, Ne or CO_2 are used as working fluids. The present analysis is aimed at finding the best-suited working fluid for the cycle for each reactor type and the most favorable cycle data for the lowest generation costs. For this condition heat exchanger surfaces and main dimensions of the turboset are determined by optimizing calculations based on a variation of the respective cycle data. A representative part of generation costs can be estimated from this together with the fuel-cycle costs. The minimum of this part of the generation costs is taken as criterion for the choice of plant components. Comparison of the results shows for He and Ne only small differences in the partial generation costs. However, for He the heat exchangers are smaller and the turbomachines somewhat longer than for Ne. Therefore He seems to be more suitable as a working fluid for a non-integrated plant design where longer machines can be accommodated, while Ne, particularly at high pressures, is attractive for an integrated plant design where little space for the turbomachines is available. Similar characteristics are found for CO_2 as for Ne; however, it can only be used at a lower temperature level. 14 references. (auth)

37606 BOILERS IN THE HIGH-TEMPERATURE GAS-COOLED REACTOR. Cameron, P. J.; O'Tallamhain, C. (Nuclear Power Group Ltd., Knutsford, Eng.). pp 571-83 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

The influence of helium as a coolant and of the higher gas temperatures possible on HTR boiler geometry is examined, and the marked reduction in heating surface and volume compared to the Advanced Gas-cooled Reactor is indicated. The pros and cons of upward and downward gas flows in the reactor core are mentioned and the consequences on boiler design discussed. The consequences of boiler leaks are explained and evidence is presented to show that boilers of the required degree of leak tightness can be eco-

nomically produced. Typical HTR boiler operating conditions are set down and suitable materials for each section indicated, having regard to both gas and water side conditions. The methods of start-up, shut-down and of control are outlined and similarities with the Advanced Gas-cooled Reactor indicated. Fault conditions can lead to severe temperature transients and these need careful analysis to ensure that overstressing of components does not occur. The load-following characteristics are briefly examined and compared with conventional plant. 4 references. (auth)

37607 STEAM GENERATOR OR HEATER FOR AN ATOMIC POWER GENERATING PLANT. Nozawa, Masao; Sako, Kiyoshi; Ueda, Hiroshi (to Japan Atomic Energy Research Inst. Nippon Kohkan Kabushiki Kaisha). U. S. Patent 3,446,188. May 27, 1969. Priority date Jan. 14, 1966, Japan.

Described is a steam generator or heater using liquid metal as a heat transmission medium having both a primary side tubing for circulating the liquid metal of a heated side and a secondary side tubing for producing and heating the steam contained in the steam generator body, and the same or a different kind of liquid metal as is used on the heated side is used in the generator vessel as a heat transmission medium between the primary and secondary side tubes. (Offic. Gaz.)

Research and Test Reactors

Refer also to abstracts 35116, 35544, 35991, 36283, 36286, 37358, 37423, 37444, and 37538.

37608 (AERE-M-2165) WUNDEE: A ONE-DIMENSIONAL RADIAL HEAT-TRANSFER COMPUTER PROGRAM FOR CONDUCTIVE AND RADIATIVE HEAT-TRANSFER SITUATIONS SUCH AS ARE MET IN REACTOR RIGS OF CYLINDRICAL FORM. Llewellyn, Susan; Cox, R. F. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1969. 49p. Dep. CFSTI. UK.

WUNDEE solves radial heat transfer problems arising on cylindrical models. The program is confined to a one-dimensional heat transfer situation and considers heat transmitted by conduction and radiation. The program is written for the IBM 360/165. 13 references. (D.C.C.)

37609 (ANL-7508) THE SUBROUTINE USED TO CALCULATE DESIGN BASIS ACCIDENTS FOR THE ZPR-6 AND -9 PLUTONIUM SAFETY ANALYSIS REPORT (ANL-7442). Rusch, G. K.; van Doorninck, J. M. (Argonne National Lab., Ill.). Dec. 1968. Contract W-31-109-eng-38. 88p. Dep. CFSTI.

A one-energy-group, point-reactor kinetics code coupled to a one-dimensional heat-transfer subroutine, which is used by Argonne National Laboratory to calculate "Design Basis Accidents" for ANL's fast critical facilities ZPR-6 and -9, is described. Heat transfer through the plate-type material geometry used in ZPR-6 and -9 is determined, and the resultant Doppler and expansion feedback reactivity is calculated and factored into the kinetics code as the assumed excursion proceeds. The code is written for the IBM 360/50-75. A listing of the code and the input requirements are included. 9 references. (auth)

37610 (BAW-3647-11) PHYSICS VERIFICATION PROGRAM. PART III. Quarterly Technical Report, October-December 1968. Baldwin, M. N.; Stern, M. E. (Babcock and Wilcox Co., Lynchburg, Va. Critical Experiment Lab.). May 1969. Contracts AT(30-1)-3647; 41-2007(RDE-2561). 35p. Dep. CFSTI.

The measurement of power perturbations produced in the area of strongly absorbing pins which simulate control rods is discussed. The critical assembly, on which these measurements were made, is described; design parameters are detailed. Power densities relative to core position are tabulated for north, south, east, and west traverses. (M.L.S.)

37611 (BNWL-874) PRELIMINARY FAULT TREE ANALYSIS FOR THE FFTF. McLaughlin, M. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 22p. Dep. CFSTI.

A preliminary fault tree analysis for the Fast Flux Test Facility is presented. The fault tree is a logic diagram showing all possible failures leading to the FFTF postulated maximum accident, release of radioactivity outside the containment. Probabilities of occurrence of the failure sequences were not calculated due to the preliminary state of the system design. It is concluded that the design of the FFTF safety system meets the established criteria in that multiple simultaneous faults are required to allow anything more serious than a minor accident. (auth)

37612 (EUR-4227) CALCULATIONS OF THE EPITHERMAL NEUTRON SPECTRA IN THE LENA (TRIGA MARK II) REACTOR AND DETERMINATION OF THE COBALT RESONANCE CAPTURE INTEGRAL. Gaggero, G.; Lesca, L.; Bresesti, A. M.; Bresesti, M.; Orvini, E. (European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). Oct. 11, 1968. 20p. Dep.

Calculations of epithermal neutron spectra in a Triga Mark II reactor, operating at Pavia University, have been performed utilizing the DTK neutron transport code and the GAZE neutron diffusion code. The calculations have shown the presence of a neutron spectrum closely approximating 1/E in the 0.68 eV–2.05 KeV energy region in some positions of the water and graphite reflectors. In these positions a value of 71.9 ± 3.5 barns has been measured for the cobalt resonance capture integral by activation techniques. (auth) (EURATOM)

37613 (KR-134) MEASUREMENT OF INTRACELL FISSION DENSITY AND FAST NEUTRON FLUX DISTRIBUTIONS IN THE NORA REACTOR WITH SOLID STATE NUCLEAR TRACK DETECTORS. Tuyn, J. W. N. (Institutt for Atomenergi, Kjeller (Norway). Reactor Centrum Nederland, Petten). Mar. 1969. 49p. Dep.

Solid state nuclear track detectors of silver-activated phosphate glass and polycarbonate plastic have provided intracell fission density and fast neutron flux distributions in the NORA reactor. The fission density distributions were measured in a clean lattice and within fuel elements in the vicinity of grey absorber control elements. The measured intracell fast neutron flux distributions were used for the evaluation of the so-called fast advantage factors (fuel-to-moderator neutron flux ratios at fission energies). Integral measurements of the fast advantage factors were performed by foil activation. As far as the experimental results presented could be compared with theoretical calculations, a good agreement was found. The use of a microdensitometer to determine the track density distributions on the surface of irradiated detectors has proved to be very convenient. A simple model for the development of tracks in solid state nuclear track detectors was constructed. 15 references. (auth)

37614 (NP-17908) ACTIVATION DOPPLER MEASUREMENTS. Tiren, L. I. (Aktiebolaget Atomenergi, Stockholm (Sweden)). [1968]. 15p. Dep.

The accuracy attainable by using activation Doppler techniques in fast critical assemblies is discussed. The activation Doppler technique is outlined. Sources of both random and systematic error are analyzed. Interpretation of experimental data is discussed. (M.L.S.)

37615 (ORNL-TM-2610) SURVEY AND ANALYSIS OF REMOTE TECHNOLOGY APPLICABLE TO DISASSEMBLY AND REASSEMBLY OF FFTF CORE COMPONENTS. Beckers, R. M. (Oak Ridge National Lab., Tenn.). July 1969. 42p. Dep. CFSTI.

A survey was undertaken to obtain data for the conceptual design of special equipment to be used for remote disassembly and reassembly of driver fuel and test assemblies in the Fast Flux Test Facility. Some machines and techniques that embody principles which would contribute to the conceptual design of the special equipment are described and evaluated. Especial attention is given to the series of machines developed at Argonne National Laboratory for work on EBR-II core components. Information on the Vertical Assembler Dismantler is particularly useful because its operating features are very similar to those that will be required for disassembly and reassembly of Fast Test Reactor fuel and test assemblies. Selected features of this machine will therefore be used for the conceptual design of the disassembly-reassembly equipment for the Fast Flux Test Facility. 22 references. (auth)

37616 (ORNL-tr-3026) PARAMETRIC STUDY OF THE NIOBE PROGRAM ON HARMONIE. Barre, B. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-Note-N-1022. 42p. Dep. CFSTI.

Capabilities of the NIOBE code for the solution to the neutron transport equation for spherical reactors are discussed. The discretization procedure that the code uses for solution to the Boltzmann Equation is described; the procedures used in the numerical solution are outlined. The various subroutines used in the NIOBE code are described. The Harmonie reactor, a low power fast reactor, is described; the mathematical model of Harmonie, constructed for the NIOBE code, is detailed. Reactor parameters are identified with respect to their influence on computational time; convergence criteria are given. Results of NIOBE calculations of neutron spectra and fluxes are shown graphically. (M.L.S.)

37617 (SGAE-R-3/1968) ASTRA FLUX CALCULATIONS WITH LARGE SCALE COMPUTER PROGRAMS. Bruneder, H.; Harrington, J.; Bochskanl, D.; Putz, F. (Oesterreichische

Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Mathematikabt.). [Jan. 1969]. 32p. (SGAE-MA-1/1968). Dep.

Flux distributions are calculated for the ASTRA reactor for a variety of different fuel-reflector configurations. The GAM program procedures are used to calculate the fast neutron spectrum. The thermalization computations are executed by the TEMPEST-II code which uses the Wilkins kernel for a heavy gas up to 0.2 eV and the Wigner–Wilkins kernel for light gas up to 0.4 eV. The two-dimensional four-group diffusion code TWENTY GRAND is used for solution to the kinetics equations. The ASTRA core is described briefly. Results of neutron flux and spectrum calculations are tabulated; the results are analyzed. 7 references. (M.L.S.)

37618 CRITICAL ASSEMBLY WITH INTERNAL EXPERIMENTAL ZONE RVEZ-1. Zeman, Jaroslav (Faculty of Nuclear and Physical Engineering, Prague). Jad. Energ., 15: 158-64 (May 1969). (In Czech).

The method of physical calculation of a reactor with an internal experimental zone RVEZ-1 is described. The reactor is designed for an experimental verification of some reactor lattice parameters. The cost of the drive zone and heavy water moderator as a function of lattice pitch of fuel elements in the drive zone is calculated. This function has a minimum. The lattice pitch of this minimum is chosen as an optimum one. Two programs for digital computer Gier are described. These programs are exploited for physical parameters calculations of the drive zone and for critical parameters and a neutron density distribution in a two-zone core with a simple reflector. 17 references. (auth)

37619 RADIOLOGICAL EXAMINATION OF FUEL ELEMENTS DISPOSED IN A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,442,511. Filed May 6, 1965.

A process and an apparatus for the radioscopic and radiographic examination of elongate fuel elements vertically disposed in a nuclear reactor of the swimming-pool type are described. The fuel element to be examined is surrounded by a hermetically closed casing which is adapted to be moved along and around said element by remote control and which contains an emitter and a receptor of radiation, e.g., x rays, disposed in such a way that the beam is directed through the element. The casing is provided with means for temporarily displacing the water of the pool from the space between the wall of the casing and the pressure tube of the element. Preferably the receptor is a photographic or a television camera, screened from γ rays, the latter permitting remote observation. The apparatus is shown in detail. (NPO)

37620 MEASUREMENT OF ANGULAR NEUTRON SPECTRA IN U–H_2O LATTICES. Mansfield, W. K.; Roshd, M. H. M. (London Univ.). J. Nucl. Energy, 22: 621-9 (Oct. 1968).

Thermal neutron spectra were measured at the center of two U–H_2O lattices with volume ratios V_{H_2O}/V_U of 1.59 and 1.11. The fuel elements were 1.2 in. dia and contained 0.925% ^{235}U. Measurements were taken perpendicular to the fuel element axis at the can surface and in the water 0.25 in. from the can. The results agreed reasonably well with those predicted by a DSN calculation (S_8-approximation) using the effective width model for scattering in water. (auth) (UK)

37621 REACTIVITY EFFECT OF REPLACING A WATER REFLECTOR WITH LEAD. Klotzkin, G.; Valentine, R. F.; Stachew, J. C.; Flanagan, C. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 337 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37622 CRITICAL AND NEAR-CRITICAL GRAPHITE-MODERATED ARRAYS OF U(93.2) CYLINDERS. Crume, E. C.; Thomas, J. T. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 336-7 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37623 CRITICALITY OF URANIUM OF LOW ENRICHMENT IN WATER. Johnson, E. B. (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 336 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37624 QUALITY ASSURANCE FOR MTR PHOENIX FUEL. Ard, P. A.; Bailey, W. J.; Gulley, R. L. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 178 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37625 AXIAL EXPANSION OF MIXED-OXIDE FUEL DURING IRRADIATION IN GETR. Cantley, D. A.; Hull, G. R.; Craig, C. N. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 108 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37626 FABRICATION OF PHOENIX MTR FUEL ELEMENTS. Curran, R. G.; Sharp, R. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 97 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37627 THE WBRR'S ROLE IN NUCLEAR EDUCATION. Brugger, R. M. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 19-20 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37628 CORE DESIGN STUDIES FOR PCC REACTOR. Angarano, C.; Strazziari, A. R. (CNEN, Bologna). Trans. Amer. Nucl. Soc., 12: 187-8 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37629 REACTIVITY WORTHS OF Pu–U CLUSTERS BY THE REACTOR OSCILLATION METHOD. Beonio-Brocchieri, F.; Boeuf, A.; Casini, G.; Macke, E.; Papay, L.; Tassan, S. (EURATOM CCR, Ispra, Italy). Trans. Amer. Nucl. Soc., 12: 198-9 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37630 COMPARISON OF EXPERIMENTALLY MEASURED AND ANALYTICALLY PREDICTED MATERIAL REACTIVITY WORTHS IN THE FLEXIBLE CRITICAL EXPERIMENT (FCX) Oblock, V. S.; Salah, S.; Freidhof, W. E. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 199-200 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37631 THE MATERIALS TESTING REACTOR 25 ±1 keV NEUTRON BEAM. Howes, B. W.; Brugger, R. M.; Rogers, J. W.; Schuman, R. P.; Simpson, O. D. (Idaho Nuclear Corp., Idaho Falls). Trans. Amer. Nucl. Soc., 12: 195-6 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37632 NEUTRON DYNAMICS IN SIMULATED-BOILING H_2O-COOLED NATURAL-UO_2 LATTICES MODERATED BY D_2O. Serdula, K. J.; Srinivasan, M. (Atomic Energy of Canada Ltd., Chalk River). Trans. Amer. Nucl. Soc., 12: 197 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37633 EXPERIMENTAL BUCKLINGS OF SIMULATED-BOILING H_2O-COOLED NATURAL-UO_2 CLUSTERS IN HEAVY-WATER MODERATOR. Srinivasan, M.; Serdula, K. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 12: 197-8 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37634 NEUTRONIC ANALYSIS OF THE PHOENIX-FUELED MTR CORE CRITICAL EXPERIMENTS. Heeb, C. M. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 245-6 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37635 NEUTRON SPECTRUM MEASUREMENTS AND ANALYSIS IN STSF-3 AND STSF-4. Young, J. C.; d'Oultremont, P.; Preskitt, C. A.; Neill, J. M. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 220-1 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37636 MEASUREMENTS OF POSITION-DEPENDENT NEUTRON SPECTRA BY THE TIME-OF-FLIGHT TECHNIQUE ACROSS A WATER-MODERATED PLUTONIUM LATTICE. Trimble, G. D.; Gozani, T.; Neill, J. M.; d'Oultremont, P.; Preskitt, C. A.; Young, J. C. (Gulf General Atomics, San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 190-1 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37637 PULSED MODERATOR TIME-DEPENDENT NEUTRON SPECTRA USING A TIME-FOCUSED CRYSTAL SPECTROMETER. Carpenter, John M.; Graham, Kingsley F. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 12: 191 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37638 EFFECT OF DELAYED NEUTRONS ON SELF-LIMITING REACTOR EXCURSIONS. Leonard, B. E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Trans. Amer. Nucl. Soc., 12: 296-8 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37639 MONTE CARLO SPECTRUM-THRESHOLD DETECTOR DATA CORRELATION IN EBR-II. Kamphouse, J. L.; Stuart, R. L.; Moteff, J. (General Electric Co.-NSP, Cincinnati). Trans. Amer. Nucl. Soc., 12: 223 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37640 SPACE-TIME KINETICS STUDIES IN A LARGE, CLOSE-TO-CRITICAL H_2O–UO_2 ASSEMBLY. Diaz, N. J.; Ohanian, M. J. (Univ. of Florida, Tallahassee). Trans. Amer. Nucl. Soc., 12: 236-7 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37641 SPACE-TIME REACTIVITY EFFECTS IN A PULSE REACTOR. Leonard, B. E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Trans. Amer. Nucl. Soc., 12: 237-8 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37642 REMOVAL OF METHYL IODIDE FROM CONTAINMENT ATMOSPHERES WITH SPRAYS. Parsly, L. F.; Soldano, B. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 326-7 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37643 ADMINISTRATIVE AND REGULATORY ASPECTS OF CRITICALITY CONTROL. Beck, Clifford K. (United States Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc., 12: 325 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37644 STANDARDIZATION OR STRANGULATION. Callihan, Dixon (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 325 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37645 SUCCESSFUL DESIGN OF A VERSATILE HYDRAULIC POSITIONING MECHANISM FOR VERTICAL-FACILITY EXPERIMENTS IN HFIR. Sweet, C. A. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 307-9 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37646 REACTIVITY WORTH MEASUREMENTS AND ANALYSIS IN THE THERMIONIC CRITICAL EXPERIMENT. Sargis, D. A.; Moore, R. A.; Cohen, S. C.; Sharp, R. (Gulf General Atomic, Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 270-2 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37647 TECHNIQUES FOR ALPHA-MEASUREMENT USING NULL-REACTIVITY METHODS IN FAST CRITICAL ASSEMBLIES. Till, C. E.; LeSage, L. G.; Stanford, G. S.; Groh, E. F.; Robinson, W. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 266 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37648 STUDIES OF SOME PLUTONIUM EXPONENTIAL ASSEMBLIES. Price, Glenn A.; Ludewig, Hans; Schiller, Richard; Chandramoleshwar, K. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 244-5 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37649 ISOTOPIC REACTION RATES MEASURED WITHIN H_2O-MODERATED, Pu-BEARING FUEL LATTICES. Carver, J. G.; Morgan, W. R.; Porter, C. R.; Robkin, M. A. (General Electric, Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 12: 243-4 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37650 FAST SPECTRUM MEASUREMENTS ON A SUBCRITICAL SECTION OF THE THERMIONIC CRITICAL EXPERIMENT. Cohen, S. C.; Moore, R. A.; Russell, J. L. Jr. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 221-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37651 SEFOR: FAST REACTIVITY EXCURSION DEVICE. McKeehan, E. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 12: 180-1 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37652 A BENCHMARK STUDY OF ZPR-3 ASSEMBLY-48 USING ENDF/B CROSS SECTIONS. Archibald, R.; Baxter, A.; Sargis, D. (Gulf General Atomics, San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 182-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37653 FTR CRITICAL EXPERIMENTS ANALYSIS. Young, W. R.; Bennett, R. A. (Battelle Memorial Inst., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 183-4 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37654 PRELIMINARY INVESTIGATION OF THE NEUTRONIC CHARACTERISTICS OF A MIXED-OXIDE FUEL LOADING OF EBR-II. Madell, J. T.; Jarka, R. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 184-5 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37655 SODIUM VOID EFFECTS IN A 4000-LITER UO_2 CORE, ASSEMBLY-6 OF ZPR-6. Karam, R. A.; Marshall, J. E.; Dates, L. R.; Rusch, G. K. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 270 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37656 DOPPLER EFFECT STUDIES AS A FUNCTION OF REACTOR SPECTRA. Pond, R. B.; Till, C. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 272-3 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37657 LINEAR COMPONENTS OF THE POWER-REACTIVITY DECREMENT OF EBR-II. Madell, J. T.; Jarka, R. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 277-8 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37658 FUEL ASSEMBLY FOR AN EXPERIMENTAL NUCLEAR REACTOR. (to Centre d'Etude de l'Energie Nucleaire). French Patent 1,368,517. Filed Sept. 5, 1963.

A fuel assembly is described which consists of a plurality of arcuate nuclear fuel plates joined edge to edge by radially extending longitudinal braces so as to form coaxial tubes. The braces are provided beyond the plates with axial extensions having a length about equal to the diameter of the outermost tube formed by the fuel plates. The ends of the extensions are joined by a ring, the inner end face of which being provided with notches mating with corresponding notches in the end faces of the extensions. The outside wall of the ring is chamfered towards its notched face in such a way that the flow of the coolant is disturbed as little as possible. (NPO)

37659 PROPAGATION OF INTERMEDIATE NEUTRONS IN SHIELDING MEDIUM. Bolyatko, V. V.; Lipunov, A. D.; Mashkovich, V. P.; Sinitsyn, B. I.; Suvorov, A. P.; Tsypin, S. G. At. Energ. (USSR), 26: 293-4 (Mar. 1969). (In Russian).

Penetration of intermediate energy neutrons through water, carbide, boron, iron, iron oxide, and heterogeneous iron-carbonic assembly (70 wt % Fe) was studied using intermediate neutron iron converter in the B-2 installation of BR-5. The converter formed a uniform disc source with ~10^5 neutrons per one neutron with E > 1.4 MeV energy with 55% neutrons concentrating in the range from 21.5 to 46.5 keV. Working equations for the angular distribution of scattered radiation are given. The measurements along the source axis, in various media, were carried out using resonance tracer, boron counters, fission chambers with ^{239}Pu, and layers of ^{235}U combined with glass. Measurements were made using detectors without filters and with cadmium or boron carbide filters. Graphic data are given on the space distribution of narrow energy group neutrons for space-energy and angular distribution. Comparisons of calculations with experimental data confirm the feasibility of using neutron fields in media from intermediate neutrons. (R.V.J.)

37660 LOW-TEMPERATURE LOOP WITH SHUTTLE AT THE IRT-2000 REACTOR. Vadachkoriya, L. A.; Katsitadze, D. G.; Naskidashvili, I. A.; Chipashvili, A. A. At. Energ. (USSR), 26: 288-90(Mar. 1969). (In Russian).

A low-temperature loop developed for a 100 mm-diameter channel of an IRT-1000 reactor was used for measuring specimens at 72 to 75 or 32 to 35°K temperature (depending on the type of cooler). The cooling of the loop was done by a closed circuit gaseous or liquid helium. During continuous experimental operations with liquid nitrogen as a cooling agent the temperature fluctuation did not exceed ±0.5°. With the reactor capacity of 2000 kW and circulating helium 0.5 g/sec the temperature of the specimen did not exceed 82 to 85°K. With the liquid nitrogen consumption 5 to 7 l/h the temperature in the working cryostat chamber was lowered to 72 to 75°K by pumping out liquid nitrogen vapor. Studies were made of radiation effects on physical properties of solids at 80°K. (R.V.J.)

37661 COOLING SYSTEM FOR A SWIMMING POOL NUCLEAR REACTOR. (to Societe INDATOM). French Patent 1,254,427. Filed Jan. 7, 1960.

A cooling system is described for a nuclear reactor having a vessel, open to the atmosphere at its upper end, containing shielding water in which an active core including a plurality of fuel assemblies is immersed close to the bottom of the pool. The fuel assemblies are supported at their lower end by two parallel horizontal grids. The casing of each assembly is divided by a vertical baffle plate into two compartments each being swept by cooling water withdrawn from the pool. Barriers are provided for impressing two opposite directions of flow successively on the water in each of the compartments. The cooling circuit which delivers the water to and collects it from the casing is provided downstream of the casing with means for deactivation and cooling down a part of the water and returning it to the pool. (NPO)

Rocket and Space Reactors

Refer also to abstract 35453.

37662 (ORNL-TM-2542) MEASUREMENT OF THE FAST-NEUTRON DOSE RATE TRANSMITTED THROUGH A LiH SHIELD WHEN USED AS A WINDOW IN IRON–OIL SHIELD MOCKUPS. Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Mar. 20, 1969. 43p. Dep. CFSTI.

Measurements were made of the fast-neutron dose rates transmitted through a LiH SNAP shield surrounded by various collar shield mockups of iron and oil. The source used was a collimated beam of neutrons from the TSR-II reactor. Data were obtained at a constant distance behind the LiH shield for combinations of several angles of neutron incidence, iron-oil configurations, and different locations of neutron incidence with respect to the shield axis. (auth)

37663 THE REFERENCE ZrH REACTOR. Maki, L. M.; Donovan, E. J. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37664 START-UP DYNAMICS OF THE S8DR REACTOR. Swenson, L. D.; Audette, R. F. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 8-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37665 MATERIAL AND NUCLEAR CONSIDERATIONS FOR MIXED-CORE ZrH-THERMIONIC REACTOR SYSTEMS. Asquith, J. G.; Swenson, L. D. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 12: 7-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37666 MEASUREMENT OF HEAT-TRANSFER PARAMETERS FOR THE GASEOUS CORE NUCLEAR ROCKET. Shenoy, A. S.; Williams, J. R.; Clement, J. D. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc., 12: 3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37667 CURVED POROUS WALL GASEOUS NUCLEAR REACTOR CONCEPT. Lanzo, Chester D. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 12: 2-3(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37668 ACOUSTIC INSTABILITY WITH NEUTRONIC FEEDBACK IN A GAS CORE NUCLEAR ROCKET. McNeill, Harry; Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 12: 1-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37669 OPTIMIZATION OF PERIPHERAL REACTIVITY CONTROL IN THE NERVA REACTOR. Bevard, D. G.; Doncals, R. A.; Mowery, A. L. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 1(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37670 MEASUREMENT OF ^{235}U AND ^{238}U FISSIONING FLUENCE DISTRIBUTIONS IN THE PHOEBUS-2A SHIELD. Watson, Clayton W. (Los Alamos Scientific Lab., N. Mex.); Trans. Amer. Nucl. Soc., 12: 382(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37671 COMPARISON OF EXPERIMENTALLY MEASURED AND CALCULATED RADIATION ENVIRONMENTS INTERNAL TO NUCLEAR ROCKET SHIELD EXPERIMENTS. Soltesz, R. G.; Oblock, V. S.; Magaw, J. R.; Stephenson, L. D.; Rankin, W. D. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 380-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37672 ANALYSIS OF THE NRX-A6 RADIATION MEASUREMENTS. Capo, M. A.; Stephenson, L. D.; Magaw, J. R. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 379-80(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37673 SHADOW SHIELD TECHNIQUES FOR MEASURING BACKGROUND DURING NERVA SHIELD EXPERIMENTS. Oblock, V. S.; Woodsum, H. C. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 378-9(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37674 NUCLEAR ROCKET RADIATION. Burnside, R. J.; Grim, D. (Boeing Co., Huntsville, Ala.). Trans. Amer. Nucl. Soc., 12: 377-8(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37675 OPTIMIZED SHIELDING FOR A NUCLEAR ROCKET PAYLOAD. Haffner, J. W. (North American Rockwell Corp., Downey, Calif.). Trans. Amer. Nucl. Soc., 12: 378(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Process Heat and Desalination Reactors

37676 NUCLEAR REACTORS: TRANSFORMING ECONOMICS AS WELL AS ENERGY. Mason, Edward A. (Massachusetts Inst. of Tech., Cambridge). Technol. Rev., 71: 26-33(Mar. 1969).

A prototypical nuclear agro-industrial complex and some of its functions and consequences are outlined. Power is supplied by 2 nuclear reactors. The electricity produced is employed in a number of energy-intensive processes, such as the production of caustic and Cl_2, and of electrolytic H_2 for manufacturing NH_3, Al and P. The water from the desalting plant is employed in the irrigation of a large, intensively operated agricultural project. (BBB)

37677 NUCLEAR POWER PLANTS FOR COMBINED POWER AND HEAT SUPPLY. Boehm, E. (Gutehoffnungshuette, Oberhausen, Ger.). pp 13-15 of Small and Medium-Size Power Reactors. Vienna, International Atomic Energy Agency, 1969.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria. See STI/PUB-217; CONF-680652.

The economic and technical possibilities are evaluated of applying reactor plants with a high-temperature reactor and a closed cycle gas turbine in a direct cycle of small and medium output. A survey showing the special features of this system of combined power generation and waste-heat utilization is presented with particular emphasis on its favorable application for combined power generation and sea-water desalination. The particular physical, thermodynamic, and technological features of the high-

temperature reactor with a helium turbine in direct cycle are described. The excellent partial-load behavior of nuclear helium-turbine plants and the considerable independence of heat supply from power generation is shown, whereby most of the heat for heating purposes or sea-water desalination is available at no extra costs. The economic application of nuclear helium-turbine plants for sea-water desalination in undeveloped and sparsely populated countries, as well as market potentialities for plants of medium output, are investigated. Data are presented on the different methods of coupling the HTR-helium turbine system to a flash evaporator for sea-water desalination. 5 references. (auth)

Marine and Portable Power Reactors

Refer also to abstract 35983.

37678 SMALL HTGR AS A PLUTONIUM BURNER. Hansen, C.; Penndorf, K. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg). pp 775-88 of Advanced and High-Temperature Gas-Cooled Reactors. Vienna, International Atomic Energy Agency, 1969.

See STI/PUB-197; CONF-681008.

A 70-MW(t) (25-MW(e)) HTGR for ship propulsion or combined power and heat generation is discussed from the point of view of its ability to burn reactor Pu economically. Several sets of economic data are used. The smallness of the core prohibits the usual method of zero-dimensional multi-group burn-up calculation. Instead, a few-group one-dimensional burn-up calculation with step-wise renewed microscopic group constants is described. 12 references. (auth)

37679 PRESSURE-SUPPRESSION TYPE CONTAINMENT VESSEL FOR A MOBILE REACTOR. Kozeki, Moribumi (to Mitsui Shipbuilding and Engineering Co.). Japanese Patent 1969-2673. Feb. 4, 1969. Filed Nov. 30, 1966.

By the method proposed, the pressure-suppression type containment vessel for absorbing the pressure in an accident in land-based reactors can also be used for mobile reactors; moreover, the structure is small in size and light in weight, and the construction itself is simple. The function is maintained at any position of the reactor. The pressure-suppression room surrounds the dry-well vessel in which the reactor core is contained. The suppression room is divided into several chambers by partitioning. A pipe runs from the dry-well vessel into the suppression chamber, respectively; a nonreturn valve is installed in the pipe. The respective suppression chambers are filled with water to an extent in which the end of the pipe is not out of the water in any posture of the nuclear reactor, including the position of falling sideways. (NSA of Japan)

37680 NUCLEAR REACTOR CONTAINMENT SYSTEM. Panoff, Robert; Rockwell III, Theodore (to Westinghouse Electric Corp.). U. S. Patent 3,446,171. May 27, 1969. Filed Nov. 22, 1966.

A containment system for a marine nuclear plant or a land-based-nuclear plant includes a containment vessel and piping means connecting the vessel to the innerbottom of a ship or to a structure having a large unoccupied volume thereby permitting vapor pressure resulting from rupture of the reactor system to be vented into the ship's innerbottom or to the enclosed volume. (Offic. Gaz.)

37681 PARAMETRIC STUDY OF LARGE NUCLEAR SURFACE-EFFECTS MACHINES. Kascak, Albert F. (Lewis Research Center, Cleveland). Trans. Amer. Nucl. Soc., 12: 4(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Production Reactors

Refer also to abstracts 36823 and 37374.

37682 (DP-1199) REPAIR OF A NUCLEAR REACTOR VESSEL. Maloney, J. P.; Baker, D.; Day, W. A.; (and others) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1969. Contract AT(07-2)-1. 101p. Dep. CFSTI.

A stress corrosion crack, which was the source of a heavy water leak of 300 pounds per day, was located with helium detection techniques in the stainless steel wall of C production reactor at Savannah River. The crack was repaired remotely with a welded patch in a radiation field $>10^5$ R/hr. Three other cracks, although not sources of leaks, were similarly repaired. The total effort required less than three months from the beginning of design, through verification of the concept in a mockup, to completion of the repair in the reactor. (auth)

37683 FORCE READOUT SYSTEM. Frantz, Charles E.; Vlacil, Frank F. (to United States Atomic Energy Commission). U. S. Patent 3,446,067. May 27, 1969.

A force-readout system employing the rotative reaction on a normally nonrotative member in a drive mechanism for indicating the force transmitted by the drive mechanism is described. Repair or replacement is performed at a reactor tube by force-applying loops driven by planetary transmissions, normally nonrotative members of which are made capable of slight angular movement which indicates the force transmitted by the force-applying loops at the reactor tube. (AEC)

37684 USE OF A DEACTIVATED HANFORD REACTOR CONTROL CENTER FOR AN OPERATOR TRAINING SIMULATOR. Bursey, R. J.; Wright, C. A. H. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 20(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37685 FIRE-RESISTANT FLUIDS FOR REACTOR SAFETY HYDRAULIC SYSTEMS. Gerrard, J. M. (Douglas United-Nuclear, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 12: 166(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Reactor Theory

Refer also to abstracts 35981, 37087, and 37138.

37686 (AEEW-M-857) ESTIMATION OF COLLISION PROBABILITIES IN COMPLICATED GEOMETRIES. Roth, M. J. (Atomic Energy Establishment, Winfrith (England)). Apr. 1969. 10p. Dep. CFSTI. UK 1s. 3d.

A method of synthesizing solutions to reactor physics problems with complicated geometries is described. Collision probability matrices are obtained for simple units and, then, put together to arrive at an approximate expression for the complicated geometry. The only assumption made is that of uniform flux which is also isotropic at the boundary. Numerical results from a WIMS computation are included to illustrate the method. (M.L.S.)

37687 COLLISION PROBABILITY THEORY FOR CYLINDRICAL CELLS WITH CLUSTER ELEMENTS USING MULTIGROUP P_N THEORY IN THE MODERATOR ZONE. Maeder, C. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Feb. 1969. 48p. Dep.

The use of collision probability theory for the calculation of neutron flux distributions in cylindrical lattice cells is described. The cylindrical cell consists of cluster regions surrounded by concentric annular zones. Anisotropic neutron scattering is considered; the finite height is accounted for by axial bucklings. A multipole expansion of the flux is used in the annular zones and, in the moderator, multigroup P_N expressions describe the flux. The multigroup integral transport equation is approximated by a system of linear equations for the spherical harmonics moments of the angular flux. (M.L.S.)

37688 (EUR-4231) PINOCCHIO: A COMPUTER PROGRAM FOR CELL REACTIVITY CALCULATIONS. Amyot, L.; Casini, G.; Cuniberti, R.; Daolio, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct. 20, 1968. 127p. Dep.

The code PINOCCHIO solves the eigenvalue problem for the infinite lattice and evaluates the variation of reactivity as a function of time for a unit cell. The integral transport equation is solved in a multigroup structure using the first collision probability formalism. Both single rods and cluster-type fuel elements are treated. The machine-time on the IBM-360 is typically of the order of 1-3 minutes per time-step. The various hypotheses underlying the model and the main features of the computer program are explained. (auth)

37689 (IA-1187) THE THEORY OF A ONE-DIMENSIONAL BARE REACTOR, TREATED BY THE LIE SERIES METHOD. Lemanska, M.; Ilamed, Y.; Yiftah, S. (Israel Atomic Energy Commission, Tel Aviv). Dec. 1968. 13p. Dep.

The one-dimensional G-group diffusion equation for the bare

reactor is solved using the Lie series technique. A method for calculating the critical size of a bare reactor is given. It is shown by numerical analysis that this method of calculation is simpler than the usual diffusion method. Numerical examples are given. 13 references. (auth)

37690 (NP-17858) ON THE SOLUTION OF NUCLEAR REACTOR AND RELATED PROBLEMS BY MEANS OF THE HYBRID COMPUTER, HYDAC-PACE. Carling, L. N. (Central Electricity Generating Board, London (England)). Computing Dept.). July 1962. 17p. Dep.

Methods for using a hybrid computer to solve reactor kinetics problems are illustrated. The analog-digital hybrid system is described briefly. The computational method is then applied to the problem of calculating temperatures and neutron flux for a single channel in the flattened region of a non-steady state core; the continuous space, discrete time (CSDT) and discrete space, continuous time (DSCT) are detailed with equations for each. Solution stability, errors encountered in truncation, and rate of convergence of the solution are discussed. (M.L.S.)

37691 (RPI-328-157) A NUMERICAL SOLUTION OF THE TIME DEPENDENT DP_L APPROXIMATION. Knickle, H. N.; Daitch, P. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). [nd]. 5p. (CONF-690609-16). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

A numerical solution for the time dependent transport equation for fast pulsed assemblies is given; the solution is accurate in the time range from fractions of a nanosecond to milliseconds. An implicit difference scheme is used to conserve spatial gradients with increasing time. Stability and convergence of the numerical solution are evaluated. (M.L.S.)

37692 INTEGRAL RELATIONS IN REACTOR THEORY. Stumbur, E. A. At. Energ. (USSR), 25: 522-4(Dec. 1968). (In Russian).

Some integral relations for reactor parameters k_{eff} or α (decrement of neutron pulse attenuation in subcritical system) were analyzed. The obtained relations were based on the precise Boltzmann equation which eliminates the non-strict aspects inherent to the diffusion or migration approximations in the theory of neutron transport. (R.V.J.)

37693 TEMPERATURE NOISE IN LOW-POWER REACTORS. Saito, Keiichi (Japan Atomic Energy Research Inst., Tokai). Nucl. Sci. Eng., 37: 316-21(Aug. 1969).

Use of the generalized Langevin equation for formulation of an expression for temperature noise is discussed. Steady state and transient temperatures are obtained for a near-critical reactor. The frequency dependence of the temperature noise sources is derived; temperature feedback is included. 12 references. (M.L.S.)

37694 DETERMINATION OF STABILITY DOMAINS IN SPACE DEPENDENT REACTOR DYNAMICS. Kastenberg, William E.; Crawford, Raymond M. (Univ. of California, Los Angeles). Nucl. Sci. Eng., 37: 311-16(Aug. 1969).

Differences and similarities in methods used to obtain stability criteria for space-dependent reactor systems are discussed. Linear and nonlinear stabilities are considered. The Lyapunov, semigroup, and comparison function stability analysis methods are applied to a specific problem; the asymptotic stability criteria are tabulated for each method. Results of the comparison are analyzed. 13 references. (M.L.S.)

37695 STABILITY AND STATIONARITY OF A REACTOR AS A STOCHASTIC PROCESS WITH FEEDBACK. Harris, D. R. (Los Alamos Scientific Lab., N. Mex.); Prescop, V. Nucl. Sci. Eng., 37: 171-9(Aug. 1969).

A reactor can be analyzed as a multiplicative stochastic process or, approximately, as a deterministic process. When feedback is present, the stochastic and deterministic analyses can differ qualitatively as well as quantitatively, as is illustrated by the concept of stability. A stochastic model of a nuclear power reactor with ^{135}Xe, ^{135}I, and control feedback is considered as an example of a nonlinear stochastic process. The values of variances and covariances are calculated from the first- and second-moment equations, using an iterative procedure. Numerical criteria for the value of the feedback coefficient for marginal stationarity of the stochastic model are compared with the corresponding criteria for the stability of the corresponding linearized deterministic model and found to be identical, within eight significant figures. 13 references. (auth)

37696 DISCRETE KINETICS FOR PERIODICALLY PULSED FAST REACTORS. Blaesser, G.; Larrimore, J. A. (EURATOM-CCR, Ispra, Italy). Nucl. Sci. Eng., 37: 186-91(Aug. 1969).

A discrete neutron kinetics for periodically pulsed fast reactors is formulated in which the time behavior of the delayed neutron precursor concentrations is considered explicitly only just before and just after each power pulse. The power pulse is represented by a delta function and a general integration of the precursor equations between pulses is used. The difference equations obtained are well suited for use in digital simulation of pulsed reactors. An inhour equation for pulsed reactors is derived from the difference equations and is shown to reduce to the relation obtained from the period-averaged kinetics equations, if the deviation from pulsed criticality is small. (auth)

37697 NEW NON-MULTIGROUP ADJOINT MONTE CARLO TECHNIQUE. Levitt, Leo B. (Atomics International, Canoga Park, Calif.); Spanier, Jerome. Nucl. Sci. Eng., 37: 278-87 (Aug. 1969).

Monte Carlo calculations based on the adjoint transport equation offer an attractive alternative to calculations based on the transport equation when the detector region is much smaller than the source region. However, when an analog simulation of the adjoint equation is attempted, extra variance may arise due essentially to the nonphysical aspects of the adjoint equation. A new adjoint Monte Carlo technique is described in which most of this additional variance has been eliminated. The method appears to be very useful for solving slowing down problems involving energies below the threshold for inelastic scattering. The basis for the technique is the idea of exactly reversing direct Monte Carlo random walks. It is shown that this reversal may be accomplished via a transformation of the adjoint transport equation by means of a discontinuous importance function. This transformation is a logical extension to continuous energies of an adjoint multigroup formulation used by Gelbard and Spanier to study thermal problems. Numerical results are provided which illustrate the variance reduction resulting from the use of this technique. 13 references. (auth)

37698 SHAPE EFFECT IN PULSED-NEUTRON MEASUREMENTS. Ronen, Y.; Fishelson, Z.; Shalev, S. (Israel Inst. of Tech., Haifa). Trans. Amer. Nucl. Soc., 12: 253(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37699 THE DISPERSION LAW OF A NEUTRON DIE-AWAY EXPERIMENT. Denning, R. S. (Battelle Columbus Labs., Ohio); Perez, R. B. Trans. Amer. Nucl. Soc., 12: 256-7(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37700 VARIANCE IN THE DOPPLER COEFFICIENT DUE TO STATISTICAL SELECTION OF RESONANCE PARAMETERS. Miller, L. B.; Hwang, R. N. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 274(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37701 METHOD TO MINIMIZE THE ADVERSE EFFECTS OF FAST REACTOR SHIM RODS ON THE DOPPLER COEFFICIENT. Paik, N. C. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 274-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37702 THE EFFECT OF HETEROGENEITY ON REACTIVITY IN A LARGE CARBIDE LMFBR. Edison, G. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc., 12: 276 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37703 SPECTRAL EFFECTS IN MULTIGROUP KINETICS. Hitchcock, J. T.; Hansen, K. F.; Henry, A. F. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 291 (June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37704 ON-LINE REACTOR NOISE SPECTRUM COMPUTATION WITH A FAST FOURIER TRANSFORM ALGORITHM. Kryter, R. C. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 291-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37705 SEMI-ANALYTIC FLUX REPRESENTATION FOR FAST PULSED ASSEMBLIES. Daitch, P. B.; Knickle, H. N. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 12: 254-5(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37706 THE DISPERSION LAW OF A LARGE, CLOSE-TO-CRITICAL H_2O–UO_2 ASSEMBLY. Ohanian, M. J.; Diaz, N. J. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc., 12: 257-8(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37707 NEW CURRICULUM IN NUCLEAR TECHNOLOGY. Bupp, L. P.; Wang, C. H. (Oregon State Univ., Corvallis). Trans. Amer. Nucl. Soc., 12: 17(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37708 ALTERING THE CLASSICAL ORDER IN THE TEACHING OF REACTOR ANALYSIS. Amster, H. J.; Chambre, P. L.; Ruby, L. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 12: 17(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37709 OPTIMAL AND NON-OPTIMAL SPACE-ENERGY NEUTRON STRUCTURES. Harms, A. A.; Babb, A. L. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 12: 143-4 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37710 SOME QUANTITATIVE RESULTS AND NEW APPLICATIONS OF THE PHASE-SPACE TIME EVOLUTION METHOD. Tavel, M. A.; Zucker, M. S. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 158-9(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37711 INCLUSION OF ENERGY-DEPENDENT BUCKLINGS IN B_N APPROXIMATIONS. Mathews, Donald R. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 157(June 1969).

37712 A NUMERICAL SOLUTION OF THE TIME-DEPENDENT DP_L APPROXIMATION. Knickle, H. N.; Daitch, P. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 12: 155-6(June 1969).

37713 SYNTHETIC SCATTERING KERNEL FOR FAST REACTOR THEORY. Waelti, Paul; Grossman, L. M. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 12: 155(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37714 MONTE CARLO EIGENFUNCTION ITERATION STRATEGIES THAT ARE AND ARE NOT FAIR GAMES. Gast, R. C. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 154(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37715 ON BOUNDED MONTE CARLO ESTIMATORS FOR FLUX AT A POINT. Steinberg, H. (Mathematical Applications Group, Inc., White Plains, N. Y.); Kalos, M. H. Trans. Amer. Nucl. Soc., 12: 153-4(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37716 A VARIATIONAL ITERATIVE METHOD FOR THE SOLUTION OF THE ENERGY-DEPENDENT DIFFUSION EQUATION. Buslik, A. J. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 152-3(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37717 ANOMALY ARISING IN THE COLLAPSED-GROUP FLUX SYNTHESIS APPROXIMATION. Adams, C. H.; Stacey, W. M. Jr. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 12: 151-2(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37718 ANOMALIES IN VARIATIONAL FLUX SYNTHESIS METHODS. Froehlich, Reimar (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 150-1(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37719 INCREASING THE ITERATIVE TIME STEP IN FAST REACTOR CALCULATIONS. Goldstein, Rubin; Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 148-9(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37720 COMPARISON OF ALTERNATING DIRECTION TIME DIFFERENCING METHODS WITH OTHER IMPLICIT METHODS FOR THE SOLUTION OF THE NEUTRON-GROUP DIFFUSION EQUATIONS. Yasinsky, J. B.; Hageman, L. A. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 145-6(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37721 A SIMPLE METHOD OF SOLVING SINGULAR INTEGRAL EQUATIONS NUMERICALLY. Robinson, Alan H. (Oregon State Univ., Corvallis); Ferziger, Joel H. Trans. Amer. Nucl. Soc., 12: 142-3(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37722 APPROXIMATE $J(\theta,\beta)$ FUNCTION. Steen, N. M. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 209-10(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37723 TWO-DIMENSIONAL BLACKNESS-THEORY BOUNDARY CONDITIONS: RZ GEOMETRY. Mendelson, M. R.; Storm, M. L.; Gazda, S. A. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 12: 210-11(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37724 DEVELOPMENT AND APPLICATION OF THE CONSISTENT P_1 MULTIGROUP DIFFUSION EQUATIONS. Lindeman, A. J.; Gallar, O. H. (Purdue Univ., Lafayette, Ind.). Trans. Amer. Nucl. Soc., 12: 211-12(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37725 COLLISION PROBABILITY MULTIPLICATION FACTOR CALCULATIONS. Hunt, D. C. (Dow Chemical Co., Golden, Colo.). Trans. Amer. Nucl. Soc., 12: 212-14(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37726 REACTION RATES AS WEIGHTING FUNCTIONS IN FAST REACTOR SPACE-ENERGY SYNTHESIS. Neuhold, R. J. (Babcock and Wilcox Co., Lynchburg, Va.); Ott, K. O. Trans. Amer. Nucl. Soc., 12: 214-15(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37727 WIDE SLAB FLUX FROM A POINT SOURCE OF NEUTRONS. Gratt, L. B.; Erdmann, R. C. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc., 12: 215-16(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37728 A UNIFIED MODAL–NODAL REPRESENTATION OF NEUTRON ANGULAR DENSITY. Harms, A. A.; McCormick, N. J. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 12: 18(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37729 ACCELERATION OF FIXED SOURCE AND UPSCATTER PROBLEMS. Sawyer, C. D.; Hill, P. R. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 12: 144-5(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37730 STABILIZED MARCH TECHNIQUE APPLIED TO INHOMOGENEOUS NEUTRON TRANSPORT. Lucey, J. W.; Riehm, P. F. (Univ. of Notre Dame, Ind.). Trans. Amer. Nucl. Soc., 12: 146-7(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37731 STABLE EXPLICIT FINITE-DIFFERENCE TECHNIQUE FOR SPATIAL KINETICS. Denning, R. S. (Battelle Memorial Inst., Columbus, Ohio); Redmond, R. F.; Iyer, S. S. Trans. Amer. Nucl. Soc., 12: 148(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37732 GENERALIZED NODAL APPROXIMATION TO THE NEUTRON TRANSPORT EQUATION. Stenstrom, D. G.; Robkin, M. A. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 12: 216-17(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37733 RESOLUTION ANALYSIS OF TIME-OF-FLIGHT SPECTRA IN SUBCRITICAL SYSTEMS. d'Oultremont, P.; Houston, D. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 219-20(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37734 SPATIAL AND ANGULAR EFFECTS ON INTEGRAL TIME QUANTITIES. Gozani, T.; Rindfleisch, C. J. Jr. (Gulf General Atomic Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 239-40(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37735 APPLICATION OF COMPARISON THEOREMS TO PROBLEMS IN SPACE-DEPENDENT REACTOR DYNAMICS. Kastenberg, William E. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc., 12: 240-1(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37736 APPLICATION OF SEMI-GROUP THEORY TO PROBLEMS IN SPACE-DEPENDENT REACTOR DYNAMICS. Crawford, Raymond M.; Kastenberg, William E. (Univ. of California, Los Angeles). Trans. Amer. Nucl. Soc., 12: 241-2(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37737 DECOUPLING AND MULTIVARIABLE CONTROL OF A COUPLED-CORE REACTOR. Weaver, Lynn E. (Univ. of Arizona, Tucson); Lewis, Christopher; Slivinsky, Charles R. Trans. Amer. Nucl. Soc., 12: 293-4(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37738 EFFECT OF DELAYED NEUTRONS ON AUTONOMOUS OSCILLATIONS IN NONLINEAR REACTOR SYSTEMS. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.); Hetrick, David L.; Schmidt, Theodore R. Trans. Amer. Nucl. Soc., 12: 294-5(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37739 DETERMINATION OF STABILITY DOMAIN OF NONLINEAR REACTOR DYNAMICS. Hsu, C.; Sha, W. T. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 295-6(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37740 TWO-DIMENSIONAL REACTOR KINETICS. Reed, W. H.; Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 12: 234-5(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37741 NUMERICAL EVALUATION OF SPATIALLY DEPENDENT DYNAMIC REACTOR SYSTEMS USING PSEUDORANDOM SIGNALS. Rydin, Roger A.; Hooper, Richard J. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 12: 235-6(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Experimental Applications

Refer also to abstracts 35277 and 35278.

37742 ANALYSIS OF FUEL-BLOCK WORTH MEASUREMENTS FOR A SMALL FAST ASSEMBLY IN A THREE-DIMENSIONAL CONFIGURATION. Sargis, D. A.; Cohen, S. C.; Moore, R. A. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Sci. Eng., 37: 262-70(Aug. 1969).

A number of fuel-block reactivity-worth measurements were performed in Core No. 1 of the thermionic critical experiment. The assembly is bare and neutronically homogeneous, but the geometry is essentially three-dimensional and the dimensions are small. A synthetic transport perturbation method is introduced for the analysis of the fuel-block worths. The agreement between experiment and analysis based upon this method is good. A useful extension of the method would be a relaxation of the first-order perturbation restriction. 16 references. (auth)

37743 MEASUREMENTS OF THE NORMALIZATION INTEGRAL AND THE SPATIAL DISTRIBUTION OF THE IMPORTANCE OF FISSION NEUTRONS. Karam, R. A. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 37: 192-7(Aug. 1969).

An experimental method for the determination of the normalization integral has been developed and used in three fast assemblies. The procedure consists of measuring the apparent reactivity associated with a calibrated ^{252}Cf neutron source at a known power level. The method is independent of the geometrical configuration of the nuclear reactor. Additionally the spatial distributions of the importance of fission neutrons were measured by observing the rate of the linear increase of the neutron population due to the ^{252}Cf source as a function of position in each fast assembly. The measured values of the normalization integrals as well as the measured distribution of fission neutron importance were higher than those obtained with multigroup calculations. 19 references. (auth)

37744 EXPONENTIAL EXPERIMENTS WITH A UO_2-LIGHT WATER LATTICE CONTAINING AIR BUBBLES. Kobayasi, Kiyosi; Hachiya, Yuuki; Iida, Yoshihiro (Tohoku Univ., Sendai). Nucl. Sci. Eng., 37: 306-8(Aug. 1969).

Experiments to measure effects of voids on the buckling and reflector savings are discussed. The experimental setup is described. Results of the experiments are shown graphically; void fraction is shown as a function of core radius and radial and axial neutron fluxes are shown for various void fractions. Buckling and reflector savings are also given as a function of void fraction. (M.L.S.)

37745 RESONANCE NEUTRON ABSORPTION IN A FOIL IN A PLATE-TYPE LATTICE. Dance, Kerry D. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 37: 300-4(Aug. 1969).

An expression for the space-dependent effective resonance integral for shielded foils is formulated in terms of standard terminology used in resonance integral calculations. The formulism is developed for plate-type lattices. Approximations and assumptions are defined. Parameters used in the sample calculation are tabulated; results of the normalized resonance integral calculations are shown graphically. 11 references. (M.L.S.)

37746 DETERMINATION OF REACTIVITY OF A SUBCRITICAL SYSTEM. Ram, K. S. (Univ. of Cincinnati); Uhrig, R. E. Nucl. Sci. Eng., 37: 299-300(Aug. 1969).

Experimental measurement of the impulse response, as a method for measuring the reactivity of a subcritical assembly, is described. The time location of the peak of the impulse response function is shown. Measurements and experimental setups for impulse response measurements in the Argonaut and the University of Florida Training Reactors are described. 12 references. (M.L.S.)

37747 EFFECT OF INFINITE REFLECTORS ON CRITICAL SLAB THICKNESS. McCormick, N. J. (Univ. of Washington, Seattle); Doyas, R. J. Nucl. Sci. Eng., 37: 308-11(Aug. 1969).

Transport equations, which include both isotropic and anisotropic scattering, for determination of critical thickness for a homogeneous, bare slab surrounded by infinite reflectors are formulated. Boundary conditions and assumptions which are used are defined. Some results of numerical calculations of slab critical thickness are shown graphically. 14 references. (M.L.S.)

37748 PRIMARY RECOIL SPECTRA AND DISPLACEMENT DAMAGE FROM ENDF/B DATA. Jenkins, J. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 12: 139(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37749 UNCERTAINTIES IN THE ANALYSIS OF PLUTONIUM-FUELED ASSEMBLIES. Liikala, R. C.; Carter, J. L. Jr.; Dwivedi, S. R.; Gelhaus, G. L.; Uotinen, V. O. Trans. Amer. Nucl. Soc., 12: 227-8(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37750 APPLICATIONS OF MODIFIED ENDF/B Pu CROSS SECTIONS TO MIXED-OXIDE CRITICAL EXPERIMENTS AND ISOTOPIC BUILDUP. Eich, W. J.; Nodvik, R. J. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 12: 228-9 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37751 NEUTRON SPECTRA IN HOMOGENEOUS MEDIA AND LATTICES CONTAINING PLUTONIUM AND H_2O. Neill, J. M.; Trimble, G. D. (Gulf General Atomic, Inc., San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 226-7(June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37752 KINETIC STUDIES IN A DEPLETED-URANIUM ASSEMBLY. Kaushal, N. N.; Malaviya, B. K.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 12: 223-4 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37753 ACTIVATION MEASUREMENT OF POSITION-DEPENDENT NEUTRON SPECTRA IN U–H_2O LATTICES. Sher, R.; Dixon, G. W. (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 12: 191-2 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37754 STUDIES OF FAST-NEUTRON CROSS SECTIONS THROUGH INTEGRAL EXPERIMENTS. Kalifelz, J. M.; Poenitz, W. P.; Sehgal, B. R.; Zolotar, B. A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 186-7 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37755 CAPTURE-TO-FISSION RATIO MEASUREMENTS OF ^{239}Pu. Iskenderian, H. P. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 267-8 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37756 LOW FLUX MEASUREMENTS OF ^{239}Pu AND ^{235}U CAPTURE-TO-FISSION RATIOS IN A FAST REACTOR SPECTRUM. Bretscher, M. M.; Redman, W. C. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 12: 265-6 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37757 MEASUREMENT OF THE ^{239}Pu-TO-^{235}U FISSION RATIO IN THE LOW keV REGION. Lehto, Wayne K. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 12: 261-2 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37758 MEASUREMENT OF INTEGRAL FISSION CROSS SECTIONS FOR ^{238}Np. Spencer, J. D.; Baumann, N. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 12: 284-5 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37759 OBSERVATIONS ABOUT CRITICALITY SAFETY. Paxton, Hugh C. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 12: 12-13 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37760 NEUTRON THERMALIZATION EXPERIMENTS IN PULSED POISONED MODERATORS. Cokinos, D.; Melkonian, E. (Columbia Univ., New York). Trans. Amer. Nucl. Soc., 12: 258 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37761 THE TIME DEPENDENCE OF THE NEUTRON POPULATION IN HEAVY MODERATORS AND THE DETECTION OF FISSILE MATERIAL. Gozani, T.; d'Oultremont, P. (Gulf General Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc., 12: 258-9 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37762 TRENDS IN CRITICALITY CONTROL. Callihan, Dixon (Union Carbide Corp., Oak Ridge, Tenn.). Trans. Amer. Nucl. Soc., 12: 23 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37763 MONTE CARLO ANALYSIS OF PHYSICS PARAMETERS IN U–H_2O LATTICES. Hardy, J. Jr. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 12: 246 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37764 EFFECTS OF VOIDS ON METHODS OF REACTOR ANALYSIS IN A SUBCRITICAL ASSEMBLY. Haroon, M. R. (Georgia Tech., Atlanta). Trans. Amer. Nucl. Soc., 12: 248-9 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37765 UNSTABLE DECAY STATES OF FAR SUBCRITICAL FAST ASSEMBLIES. Dorning, J.; Nicolaenko, B.; Thurber, J. K. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 12: 251-2 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37766 MOMENTS CALCULATION OF PSEUDO-FUNDAMENTAL DECAY CONSTANTS IN FAST SYSTEMS. Zolotar, Burt A. (Centre d'Etudes Nucleaires, Cadarache, France). Trans. Amer. Nucl. Soc., 12: 253-4 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37767 OPTIMIZATION OF PULSED-NEUTRON AND OTHER EXPERIMENTS DESIGNED TO MEASURE EXPONENTIAL DECAY CONSTANTS. Szeless, Andreas; Ruby, Lawrence (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 12: 255 (June 1969).
From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

Reactor Components, Fuels, and Accessories

Refer also to abstracts 35109, 35257, 35261, 35286, 35289–35294, 35296, 35297, 35300–35306, 35308, 35309, 35315–35321, 35338, 35360, 35368–35370, 35372–35374, 35377–35379, 35383, 35384, 35389, 35437, 35454, 35458, 35476, 35541, 35546, 35562, 35564, 35568, 35984, 35990, 35995, 36002, 36032, 36034, 36035, 36037, 36041, 36048, 36049, 36059, 36067, 36090, 36092, 36093, 36099, 36114, 36157, 36169–36171, 36175, 36179, 36183–36185, 36187–36190, 36193–36195, 36202–36206, 36209–36213, 36217, 36223, 36224, 36252, 36262, 36270, 37068, and 37444.

37768 (AEEW-M-860) NUMERICAL STUDIES OF THE HYDROGEN EQUIVALENT OF SOME STRUCTURAL MATERIALS IN THEIR EFFECT ON ^{238}U RESONANCE CAPTURE. Aldous, A. C. (Atomic Energy Establishment, Winfrith (England)). Mar. 1969. 9p. Dep. CFSTI. UK 1s. 9d.
A set of values of λ, a parameter used by the resonance treatment in the WIMS lattice code to determine the hydrogen equivalent of a moderating material, is evaluated for some important reactor constituents. Energy-dependent values are tabulated for some moderating materials, and a graph is given showing effective one-group λ values plotted against atomic weight, so that one-group λ values for all nuclides can be deduced. The sensitivity of λ to the amount of moderating material present in the system is also tested. (auth) (UK)

37769 FUEL ELEMENTS FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,415,970. Oct. 29, 1964.
The container of the element is provided on its outside with cooling fins. In order to prevent deformation of the fins by the forces exerted by the flowing coolant, they are interconnected by one or more narrow strips, preferably of the same material, which are soldered to a peripheral point of each fin. Dependent on the pattern in which the fins are arranged, the strips are mounted in a longitudinal or transversal direction with respect to the element or as a helix surrounding the element. (NPO)

37770 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,286,411. Filed Apr. 17, 1961.
Described is an element of elongate form having its ends equipped with members that made it possible to stack a series of elements in the coolant channel of the reactor. In order to stabilize the element against vibration it is provided near one end with a member extending part-way round the periphery of the element so that when it is exposed to the coolant flow a lateral component of force is exerted by the flow to move the element into a stable position against the wall of the coolant channel. Members of different form are described. (NPO)

37771 DEVICE FOR CENTERING FUEL ELEMENTS IN A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,328,540. Filed Apr. 20, 1962.
The sheath of the element is provided on its outside with cooling fins arranged in a herringbone pattern. The element is centered in relation to the cylindrical wall of the coolant channel by at least three longitudinal fins of substantially equal length to the element which are fastened to the wall of the channel and are radially engaged in the longitudinal grooves which separate the

adjacent series of fins of the herringbones. Various forms of centering fins are given. (NPO)

37772 DEVICE FOR CENTERING FUEL ELEMENTS IN A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,328,539. Filed Apr. 20, 1962.

The sheath of the element is provided on its outside with cooling fins arranged in a herringbone pattern. The element is centered in relation to the cylindrical wall of the coolant channel by at least three centering devices, two of which are positioned at the extremities of the element. Each device is composed of a number of longitudinal lugs which are fastened to the wall of the coolant channel and are radially engaged in the longitudinal grooves which separate the adjacent series of fins of the herringbones. (NPO)

37773 DEVICE FOR ASSEMBLING A NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,438,430. Filed Mar. 30, 1965.

Described is a device for assembling a fuel element comprising an annular sleeve, a support within said sleeve on which the element rests, and at least three members uniformly spaced around the axis of the element, each of which engages a recess in the internal surface of the sleeve and a recess in the support, said members being held in position under the action of the weight of the support and the element. Said device comprises a hollow cylindrical body over which the lower end of the sleeve is adapted to engage to a partial extent, a moving plunger which is guided axially within said hollow body and the head of which is adapted to receive the support, and blade springs on the plunger for retaining the support thereon. The hollow body is provided at the upper end, which will penetrate into the sleeve, with slots for the positioning of said members and with other blade springs for retaining the members in the slots. The plunger is provided with an inclined ramp such that displacement of the plunger from the sleeve will initiate outward displacement of the members into said recesses so as to free the support from the plunger head. Preferably a lever is provided to control the displacement of the plunger within the hollow body, the lever being pivoted about a pin in a vertical plane, lateral slots being provided in the hollow body for receiving the lever which cooperates with a transverse locking-pin carried by the plunger. (NPO)

37774 FISSIONABLE NUCLEAR FUEL PARTICLES FOR HIGH OPERATING TEMPERATURES. (to EURATOM). French Patent 1,410,047. Filed Sept. 30, 1964.

Described are nuclear fuel particles having a kernel which includes a carbide or oxide nuclear fuel and at least one coating containing carbon which has been applied to the kernel by pyrolytic means. In order to fit the particles for use at high operating temperatures they are heated for a short duration in an inert atmosphere to a temperature of at least 1700°C, which results in the formation of a reaction layer in the coating, acting as a diffusion barrier. Preferably the particles are provided with a further layer consisting of a refractory metallic carbide, e.g., Zr-carbide, to which one or more layers of pyrolytic carbon are applied. In a modification a layer of a refractory metallic carbide is interposed between the kernel and the first pyrocarbon-layer, said carbide forming a solid solution with uranium and containing excess carbon. (NPO)

37775 NUCLEAR FUEL ASSEMBLY. (to Gesellschaft fuer Kernforschung mbH). French Patent 1,493,285. Filed Sept. 19, 1966.

A fuel assembly is described which comprises a plurality of spaced parallel fuel bars disposed in a casing through which a coolant is circulated. In order to maintain the bars in their spaced position they are arranged in rows and are provided at both ends with longitudinal support rods, the rods of each row being aligned on a pin which is attached to a common support member. The mounting is effected in such a way that thermal expansion of the fuel bars when raised to the operating temperature is possible. (NPO)

37776 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,473,035. Filed Dec. 7, 1965.

A fuel assembly is described which has a cluster of parallel fuel rods disposed within a sleeve of structural material. The rods are supported at their lower ends, the support means also serving for independently supporting the sleeve at the lower end. A member for lateral spacing of the rods is disposed in the region of their upper ends and optionally one or more spacing members may be provided intermediate the upper member and the support means, each of the spacing members being secured in longitudinal position by being mounted on a central longitudinally extending member which is itself mounted on the support means. The fuel rods are slidable relative to each spacing member and each spacing member being slidable relative to the sleeve. Preferably the central member is tubular and provides accommodation for a lifting member by means of which the assembly can be charged into or discharged from the channel of the reactor. Several details are shown in the drawings. (NPO)

37777 IMPROVEMENT IN NUCLEAR FUEL ASSEMBLY. (to Gesellschaft fuer Kernforschung mbH). French Patent 1,442,051. Filed Aug. 2, 1965.

A fuel assembly is described which comprises a plurality of spaced parallel vertical canned fuel rods arranged in a regular cross-sectional pattern, e.g., a pattern of squares. The cans of the rods are interconnected by short, preferably tubular, support members which are fixed to the cans in at least two different horizontal planes. An improvement in the mechanical resistance of the structure at the operating temperature is achieved by providing some of the fuel rods, also arranged in a regular pattern, with a higher quantity of fertile material than the others and only interconnecting the cans of the rods with a higher content of fertile material by the support members. Various constructions are given. (NPO)

37778 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,446,216. Filed Sept. 4, 1965.

An assembly of sheathed fuel plates for a nuclear reactor is described. The assembly comprises plates the sheathing formed by corrugated halves of uniform thickness sheet united at the concavities of the corrugations to form longitudinally extending pockets. A discrete mass of nuclear fuel is contained in each pocket. The corrugations of adjacent plates are positioned in such a manner as to leave between the plates a gap of constant width for coolant flow. In a modification the halves are fabricated of separate channels joined in parallel relation along their edges by welding. The edges are in lapped relation and form projections acting as continuous spacer ribs in engagement with the concavities of adjacent plates. (NPO)

37779 NUCLEAR FUEL ASSEMBLY AND PROCESS FOR ITS PRODUCTION. (to United Kingdom Atomic Energy Authority). French Patent 1,431,265. Filed Mar. 17, 1965.

An assembly of plate fuel members is described. Each fuel member consists of an elongate plate of fissile material protectively roll-clad in a nonfissile material. The fuel members are secured to support members and to one another by welded joints at contacting joint faces. The welding is effected by the employment of electron beams. Preferably the support members have, at their portions which are disposed between adjacent fuel members, recesses provided by removal of material so as to reduce the amount of material which needs to be penetrated by the electron beams. (NPO)

37780 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,239,111. Filed Oct. 23, 1959.

A plate-type nuclear fuel assembly is described which comprises a series of connected and spaced coaxial fuel tubes formed by arcuate plates containing fissile material. The plates are secured along their edges to radial supports extending axially of the fuel tubes and providing a plurality of continuous heat conducting paths from the inner to the outer coaxial tubes. Preferably the supports are Y-shaped in section, the foot of the Y-section being adjacent to the innermost of the coaxial fuel tubes and the mouth of the Y-section being of a size such that the arcuate plates are of equal size. (NPO)

37781 NUCLEAR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,492,906. Filed May 3, 1966.

A fuel assembly which comprises a top blanket cluster of fertile pins, a central cluster of fuel pins and a bottom blanket cluster of fertile pins is described. The fuel pins of the central cluster are of smaller diameter and larger number than the fertile pins of the blanket clusters. In order to extract the gaseous fission products formed in the fuel pins during operation the fertile pins are provided with a narrow central channel connected at its inner end to a number of fuel pins and at its outer end to an evacuated collector chamber. Two of such chambers are provided inside the casing, one being disposed at the top of the assembly and communicating with the channels in the pins of the top cluster, the other being disposed at the bottom of the assembly and communicating with the channels in the pins of the bottom cluster. (NPO)

37782 NUCLEAR FUEL ASSEMBLY. (to Siemens-Schuckertwerke AG). French Patent 1,492,120. Filed May 18, 1966.

A fuel assembly comprising a plurality of spaced parallel fuel bars which are mounted in a lower and an upper support plate is

described. Both support plates are provided with holes allowing circulation of a coolant along the bars. In the open space between the bars tubular members of the same length are mounted, the outer surfaces of which are provided with helical fins or protuberances, serving simultaneously to center the bars and to bring about turbulence of the coolant. The tubular members may have a circular or preferably a cruciform cross-section, adapted to the form of the open space between the bars. The tubes are provided at the top and at the bottom with tiny holes, permitting a slow stream of coolant through the tubes, having a temperature which is lower than that of the coolant outside the tubes. In a modification tubes of circular cross-section surround the fuel bars, the main stream of coolant being fed through the tubes and the slow stream of coolant being circulated outside the tubes by means of tiny holes provided in the support plates. In another modification reversed U-tubes are used, the coolant being fed into one leg and entering the space between the bars from the exit of the other leg. (NPO)

37783 FUEL ELEMENT AND ASSEMBLY FOR NUCLEAR REACTOR. (to Rolls-Royce Ltd.). French Patent 1,160,982. Filed Nov. 30, 1956.

A fuel element is described comprising a plurality of layers of clad uranium. The layers are formed integrally from a single thin sheet of clad uranium and are held in spaced relation to provide flow paths for the coolant. The sheet is wound into a spiral and the convolutions are held in spaced relation by rods inserted axially between the convolutions. A plurality of such elements can be assembled by arranging them end to end in a tubular casing. The elements are provided with axial projections to abut with axial notches in adjacent elements to hold them in axially spaced relation. (NPO)

37784 NUCLEAR FUEL ASSEMBLY. (to Allmaenna Svenska Elektriska Aktiebolaget). French Patent 1,482,246. Filed May 4, 1966.

A fuel assembly is described which comprises a plurality of spaced parallel fuel rods. The lower ends of the fuel rods are fastened to a bottom support plate, their upper ends being slidably mounted in a top support plate. This permits thermal expansion of the rods when raised to the operating temperature. Members for lateral spacing of the rods are disposed intermediate the support plates. The distance between the spacing members is determined by a longitudinally extending support structure to which the members are fastened in such a manner that a slight displacement in longitudinal direction between the members and the structure can take place. Preferably the assembly has a polygonal cross-section in which case the support structure consists of a number of angular bars disposed inside the casing near the edges. In a modification the structure is formed by the casing itself. (NPO)

37785 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,369,655. Filed Sept. 13, 1963.

A fuel assembly is described which comprises a plurality of parallel fuel plates spaced apart to form coolant channels and means associated with each fuel plate whereby the coolant may cross-flow from one channel to another. The fuel plates are axially spaced along an apertured tubular member. The apertures in the member are in register with the coolant channels between the fuel plates. The fuel plates may be assembled between two parallel end walls and the sides of the assembly closed by side walls thin in relation to the end walls. The side walls are provided with projecting abutment means for spacing apart adjacent fuel plates in such way that the adjacent side walls of the plates are supported against outward distortion. The fuel plates may also be apertured themselves to promote coolant cross-flow. The apertures are lined to prevent exposure of the plate core to the coolant. (NPO)

37786 METHOD FOR MANUFACTURING FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,463,188. Filed Nov. 12, 1965.

Described is a cylindrical fuel element, which is provided on the outer wall with cooling fins arranged in a herringbone pattern. The axis of each herringbone is formed by a longitudinal baffle running the length of the element. The manufacture is facilitated by fastening the baffles hinge-like to one of the circular end caps, the other end cap being provided with bayonet-catches. (NPO)

37787 IMPROVEMENTS IN CONTAINERS OF FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,394,989. Filed Feb. 27, 1964.

Described is a container, which is provided with cooling fins, arranged in a herringbone pattern. The improvements consist in a longitudinal undulation of the upper half of the fins. The wavelength is selected in such a way that there are from a half to two complete waves along the whole length of the fins, dependent on their position in the pattern. The amplitude amounts preferably and maximally to half of the width of the channels between the fins. (NPO)

37788 IMPROVEMENT IN CONTAINERS OF FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,379,968. Filed Jan. 3, 1964.

In order to improve the heat transfer from the container to the coolant, the outer surface of the container is provided with a helix of metal wire, preferably of the same chemical composition, e.g., stainless steel. Several methods for brazing the wire to the surface are described. (NPO)

37789 IMPROVEMENT IN CONTAINERS OF FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,393,550. Filed Feb. 14, 1964.

The outer wall of the container is provided with cooling fins, arranged in a chevron pattern. In order to prevent deformation of the fins by the forces exerted by the flowing coolant each fin is provided in its outer part with a slot in such a way as to form an interrupted channel running the length of the container. The depth of the slots has to be less than a third of the height of the fins. Preferably they are situated not far from the edge of the channels between the chevrons. In a modified construction the slots are replaced by a series of small holes. (NPO)

37790 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,402,588. Filed July 29, 1964.

Described is a fuel element, having a sheath of elongate form provided with groups of antibowing lugs spaced along the length of the sheath, each group being equispaced circumferentially around the sheath. In order to restrain vibration of the element induced by the flow of the coolant at least one of the antibowing lugs situated at the end of the sheath is provided with a level arm, pivoted on the lug, and with a spring, tending to push the arm outwards so as to bear against the wall of the coolant channel. (NPO)

37791 FUEL ELEMENTS FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,399,833. Filed May 22, 1964.

A fuel element of the flat plate type is described. The flat faces of the sheath on both sides of the element are provided with cooling fins arranged in a herringbone pattern. Longitudinal lugs projecting from the narrow edges of the element engage in longitudinal grooves in the wall of the coolant channel, thereby positioning the element diametrically across the channel. The lugs are provided with longitudinal bars of neutron moderating material, e.g., graphite. Various constructions are described. (NPO)

37792 FUEL ELEMENTS FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,347,081. Filed Oct. 26, 1962.

The tubular fuel element comprises an annular container closed by annular caps. If such elements are stacked in columns their weight brings about deformation of the thin-walled caps. In order to prevent this the caps are shaped in such a way as to have an area of contact with the material inside the container superior to the cross-section of the fuel in the container. Various constructions are described. (NPO)

37793 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,399,040. Filed May 27, 1964.

Fuel elements for nuclear reactors which are stacked in columns in a vertical coolant channel of the reactor are described. They are provided with positioning members projecting from their sheaths for engagement with longitudinal locating grooves in the wall of the channel. To allow the elements to be lifted out of the channel during refuelling of the reactor said members must be capable of sliding freely in said grooves. In consequence a clearance must be provided between the members and the grooves. Because of this clearance the elements will be subject to transverse vibration induced by the coolant flow. In order to prevent this vibration one or more of the members are provided with spring locating means bearing against the side wall of the corresponding groove. Various constructions are given. A method for providing the stack of elements with thermocouples is described. (NPO)

37794 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTOR. (to United States Atomic Energy Commission). French Patent 1,483,433. Filed June 15, 1966.

Described is a fuel assembly comprising a generally cylindrical casing having retainer means provided at about 60° radial spacing in the inner peripheral walls thereof, and pairs of spacer devices formed as open triangles of deflectable semi-rigid sheet material having nodular loops at each corner of said triangle and a geometric axis perpendicular to the plane of said triangle. Adjacent members of each of said pairs are rotated 60° with respect to each other about the longitudinal axis of the assembly and are disposed within said casing with said loops engaging said retainer means, whereby elongated fuel rods disposed in the spaces defined by triangular and cylindrical walls are retained in spaced relation therein. Preferably said casing includes rounded indentations deformed radially inward in said casing and circumferentially spaced every 60° and longitudinally spaced along the casing to engage the loop portions and retain a pair of said spacers. (NPO)

37795 NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,215,911. Filed Mar. 17, 1964.

A fuel element is described comprising a fuel member surrounded by a sleeve and means for supporting said fuel member in said sleeve comprising a cylindrical disc-shaped member positioned at the base of the sleeve and centrally thereof. The cylindrical member is connected with the sleeve by two identical metal hairpin-like members threaded directly through both the sleeve and the cylindrical member and supported in two directions perpendicular to one another, the ends of the hairpin-like members being adapted to engage in a circumferential groove in the outside of the sleeve and to be joined together by welding. (NPO)

37796 SPACING DEVICE FOR NUCLEAR FUEL ASSEMBLY. (to Licentia Patent-Verwaltungs GmbH). French Patent 1,456,400. Filed Dec. 7, 1965.

Described is a device for spacing apart a plurality of parallel nuclear fuel rods which comprises a substantially flat frame and a plurality of resilient wires arranged to form a matrix for receiving the fuel rods, each of said wires having its ends connected to said frame and having a zigzag shape which causes said wire to present a plurality of contacting points extending transversely to a line joining the ends of said wire and to a reference plane extending parallel to the median plane of said frame, each of said contacting points being arranged to bear against one of the fuel rods to be spaced from one another. In a modification the contacting points are arranged in a plurality of pairs with both points of each pair being disposed on the same side of said reference plane which passes through the line joining the wire ends and with each successive pair being disposed alternately on opposite sides of the reference plane. (NPO)

37797 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Chetter, John; Jones, Cecil Henry (to United Kingdom Atomic Energy Authority). U. S. Patent 3,442,763. May 6, 1969. Priority date July 21, 1966, Great Britain.

Described is a spacer grid for a nuclear fuel assembly of cellular form with a square framework, in which the cells are penetrated by fuel pins, each pin being positioned in its cell by two spaced stop means and a resilient means arranged so that the resilient means is positioned at the apex of an isosceles triangle relative to the stop means which are positioned at the basal corners of the isosceles triangle. The points of contact of the stop and resilient means with the fuel pins lie in the plane of the grid structure. (Offic. Gaz.)

37798 IMPROVEMENTS IN OR RELATING TO A METHOD OF ASSEMBLING A REGULAR POLYGONAL ARTICLE FROM A NUMBER OF BLOCKS. Hosegood, Samuel Brittan (to United Kingdom Atomic Energy Authority). British Patent 1,151,855. May 14, 1969. Filed July 30, 1965.

The system described is stated to be particularly applicable to blocks of nuclear reactor moderator material, such as graphite, and refers to a columnar structure whose cross-section is a regular polygon having n sides assembled as an interlocked stack of identical layers, with each of n identical wedge-shaped blocks having mutually inclined side faces, so that the blocks lie side by side in a layer, interlocking being achieved on the interfaces between the layers by having on each block a number of projections or recesses on opposite faces sized and located so that the layers fit together with the projections or recesses of one layer engaging those of another layer. (UK)

37799 PIPE RELIABILITY ESTIMATING BY THE DISTRIBUTION OF TIME-TO-DAMAGE METHOD. Wilson, S. A. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 12: 171-2(June 1969).

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash. See CONF-690609.

37800 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY FIFTEENTH ANNUAL MEETING, JUNE 15–19, 1969, SEATTLE, WASHINGTON. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc., 12: 1-404(June 1969). (CONF-690609).

The transactions include summaries of 435 papers. Each paper is title listed in NSA. (D.C.C.)

For abstracts of individual papers see: 34990, 34991, 35007–35009, 35038–35042, 35072–35078, 35167–35169, 35269–35280, 35352, 35383–35387, 35406–35414, 35420–35422, 35424–35430, 35441, 35444–35447, 35484–35486, 35507–35510, 35530–35533, 35560–35568, 35575, 35579, 35620, 35744, 35745, 35892, 35893, 36014–36019, 36050–36052, 36093–36101, 36148–36164, 36206–36208, 36230–36234, 36252, 36276–36288, 36675, 36758–36785, 36811, 37058, 37076–37088, 37162, 37163, 37231–37244, 37332–37339, 37417–37442, 37458, 37463–37479, 37487, 37488, 37497, 37525–37546, 37557, 37568–37600, 37621–37657, 37663–37675, 37681, 37684, 37685, 37698–37741, 37748–37767, and 37799.

37801 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,399,858. Filed June 5, 1964.

The container of the element is provided with cooling fins arranged in a chevron pattern. The fins are fastened at their base and their extremities. A change in temperature brings about an erratic deformation of the fins by which their parallelism is impaired. If the surface of the element is curved (e.g., cylindrical) erratic deformation is prevented by providing the fins with one or more narrow slots which extend from the top to the base. If the surface is flat a slight cylindrical incorvation is imparted to the fins, which increases or decreases depending on the temperature. (NPO)

37802 PRESSURE CANNING PROCESS FOR NUCLEAR FUEL ELEMENTS. (to Commissariat a l'Energie Atomique). French Patent 1,408,881. Filed July 9, 1964.

A pressure canning process for producing a fuel element is described wherein the fuel in the form of a stack of pellets enclosed in its can is disposed during the canning operation in a rigid outer casing, e.g., a thick-walled steel tube. The steel tube has an inside diameter slightly larger than the outside diameter of the can and a shape matching the shape of the can. Canning may be carried out under a pressure of 1000 kg/cm^2 in the cold state in a hydraulic canning machine of the water or oil type or alternatively in a hot-gas canning machine. If the can is provided with cooling fins the inside of the casing is a female version of the shape of the fins. (NPO)

37803 ASSEMBLING NUCLEAR FUEL PLATES. (to Commissariat a l'Energie Atomique). French Patent 1,468,912. Filed Nov. 12, 1965.

A method for attaching a plurality of fuel plates to a common support plate is described. The latter is provided on one or both sides with a series of parallel rectangular grooves of a certain depth. These grooves are intended to accommodate an end-portion of the fuel plates to be assembled. The end-portions are provided with a saw-cut, preferably of semicircular cross-section, in such a manner that the distance between its inner edge and the adjacent edge of the fuel plate equals the depth of the grooves in the support plate. After insertion of the end of a fuel plate into one of the grooves, tongues of material of the support plate are cold-forged into the saw-cut by hammering in an angular direction. The distance between the tongues preferably amounts to 2 to 5 mm. (NPO)

37804 PROCESS AND APPARATUS FOR CANNING NUCLEAR FUEL ELEMENTS. (to Commissariat a l'Energie Atomique). French Patent 1,408,883. Filed July 9, 1964.

A process for producing a canned fuel element closed by welded plugs is described. The element is disposed in an apparatus comprising a cage which supports the element vertically during the canning operation. The cage is designed to protect at least one of the welded zones of the element. A preferred form of the apparatus, shown in an accompanying drawing, comprises a base provided with a check ring for supporting and protecting the bottom welded zone of the element. Vertical rods connected to the base from a squirrel cage, and a ring completing the cage is slidable on the rods which support the top of the element. The rods have stops against which the ring abuts. Preferably the ring also serves as a protection for the top welded zone of the element.

The canning operation is carried out by the application of a high hydrostatic pressure in the cold or hot state. (NPO)

37805 ACTUATING MECHANISMS FOR CONTROL RODS USED IN NUCLEAR REACTORS. Hanson, Douglas Oliver (to Nuclear Power Group Ltd.). British Patent 1,154,687. June 11, 1969. Filed May 16, 1967.

The system described comprises a rotatable member around which passes a flexible number supporting a control rod in a vertical position. An electromagnetic clutch transmits a driving torque to the rotatable member when energized to raise or lower the control rod. When de-energized the rod is permitted to fall under its own weight into the reactor. The mechanism also includes a mechanical variable inertia device for controlling acceleration of the rod during its fall. The inertia device may be adapted to allow a constant acceleration over the initial part of the fall and then to increase the inertia of the falling rod through the remainder of its fall, decreasing the speed of the rod in a predetermined manner. The inertia device may be driven through a free-wheel coupling by a shaft connecting the rotatable member to its driving means, such that the free fall of the rod under its own weight transmits a drive through the shaft to a centrifugal governor forming part of the inertia device. (UK)

37806 NUCLEAR REACTOR FUEL ELEMENTS. Saunders, Alan Charles Anthony; Pickman, David Openshaw (to United Kingdom Atomic Energy Authority). British Patent 1,154,618. June 11, 1969. Filed Nov. 29, 1966.

It was found that in fuel elements comprising enriched UO_2 pellets contained in Zr alloy sheaths the butt welded end closures may fail. In the fuel element described the ceramic pellet adjacent to the butt weld has a lower fissionable isotope content than the remainder of the pellets. The butt weld may encircle a peripheral recess in this pellet, and this recess may comprise an end chamber. The method of fabrication is described in detail. During reactor operation the enriched pellets expand to fit the sheath closely over most of its length, but the end pellet generates less heat and remains freely fitting in the sheath; in this way the axial force caused by extension of the stack of pellets can be accommodated by ductile extrusion of the sheath extending over the freely fitting pellet, instead of concentrating stress on the weld. (UK)

37807 FUEL ELEMENTS FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,360,054. Filed May 29, 1963.

The sheath of the fuel element has a herringbone configuration of cooling fins on its outside. In order to restrain bowing of the element during operation the sheath is provided with a plurality of radial lugs which are disposed at spaced positions along each line of junction of the adjacent series of fins forming the herringbone. The lugs extend nearly to the wall of the coolant channel. In a modification the lugs of one longitudinal set are thicker than the remainder and are drilled through longitudinally to carry thermocouple leads to a hot junction disposed in the wall of the sheath. (NPO)

37808 SPACING DEVICE FOR NUCLEAR FUEL ASSEMBLY. (to Allmaenner Svenska Elektriska Aktiebolaget). French Patent 1,487,538. Filed July 2, 1966.

A device for spacing apart a plurality of parallel elongate circular fuel elements is described. The fuel elements are arranged so as to form a pattern of squares in the cross-section of the assembly. The spacing device comprises an upper and a lower square-meshed grid of strip material. The fuel elements extend through aligned meshes of the grids. The grids are interconnected at the angular points of the squares by means of four spring strips facing the diagonals of the squares and provided midway between the grids with an incurvation the top of which contacts the adjacent fuel element. In a modification each fuel element is surrounded by a one-piece cell comprising an upper and a lower square of strip material interconnected in the manner described. The squares are brazed together so as to form the square-meshed grids. (NPO)

37809 NUCLEAR REACTOR. (to Pierre Legrand). French Patent 1,434,932. Filed July 18, 1963.

A nuclear reactor comprising parallel piles of fuel elements mounted in a common cooling channel is described. The outer walls of the elements are provided with cooling fins arranged in a conventional pattern. In order to equalize the surface temperatures of the elements longitudinal strips of heat conducting material are inserted between the piles. The strips are twisted lengthwise, adjacent strips being wound in opposite directions. As an additional measure the interspaces of the cooling fins may decrease in the direction of flow of the coolant. (NPO)

37810 NUCLEAR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,500,151. Filed July 26, 1966.

A fuel assembly comprising a plurality of parallel equally spaced vertical fuel plates is described. The fuel elements are mounted in a bottom support member and are held in spaced relation by two lateral support plates which are provided with equally spaced vertical grooves engaging the longitudinal edges of the fuel plates. The lateral plates are hinged upon two axes the ends of which are fixed in two transversal bars, parallel to the main plane of the fuel plates, and preferably forming part of the bottom supporting member. In this way the fuel plates are easily accessible for inspection and replacement. (NPO)

37811 NUCLEAR FUEL ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,342,655. Filed Jan. 7, 1963.

A fuel assembly is described which consists of an elongate tubular casing and a pack of fuel plates extending axially within the casing. Interleaved between the fuel plates as well as between the outer plates of the pack and the respectively opposing walls of the casing, unfueled sheet metal spacers are placed which are substantially co-extensive with the plates and are corrugated to give lines of contact with the plates extending continuously from one end of the pack to the other. The spacers are compressible resiliently by virtue of the corrugations and the dimensions of the casing are such that the spacers are under compression when the fuel plates are housed in the casing. Preferably the curvature at the apexes of the corrugations in contact with the faces of the fuel plates is such as to permit penetration of coolant into the contact angle. With a metal coolant, e.g., Na or a Na-alloy, the pitch of the corrugations should not be greater than seven times the separation between opposed faces of adjacent fuel plates. (NPO)

37812 NUCLEAR FUEL ASSEMBLY AND NUCLEAR REACTOR CORE. (to EURATOM). French Patent 1,500,204. Filed Aug. 23, 1966.

A fuel assembly is described which comprises a plurality of vertical fuel plates having a cross-section shaped as a sector of a circle. The narrow ends of the plates are fixed to a central bar and their broad ends are welded to the inner wall of a casing of circular cross-section. The plates are circumferentially equally spaced leaving between them vertical capillary channels which form together with the top and the bottom plates of the assembly hermetically closed chambers containing a heat conducting liquid. The inner wall of the casing and the outside of the cladding of the plates are provided with horizontal capillary grooves having a rectangular cross-section. A nuclear reactor core may be built on the same principle, the radially extending plates being fixed to a vertical tube which surrounds an absorption bar, and containing from their inner to their outer ends a fissile material, a reflector and a structural material which are welded to the inner wall of the vessel. The vessel is separated from the surrounding pressure wall by a cylindrical expansion space containing He. (NPO)

37813 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,400,289. Filed July 7, 1964.

A fuel element is described comprising a sheathed fuel body supported in a graphite sleeve. The fuel body and the sleeve are interconnected by an overload coupling. The fuel body also contains an extension for a handling grab whereby, should the sleeve become jammed in the channel of the reactor, the fuel body may be disconnected from the sleeve by exerting sufficient withdrawal force on the body to break the overload coupling. Preferably the coupling comprises a shear pin in engagement with an end fitting of the fuel body and also with a bridge piece spanning the sleeve and serving for supporting the fuel element in the sleeve. The sheath of the fuel body is provided with coarse-pitch helical cooling fins and with longitudinal flow dividers of greater radial height than the fins. The outer edge portions of the dividers are engaged in longitudinal slots in the internal surface of the sleeve. (NPO)

37814 FUEL CARTRIDGE FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,339,587. Filed July 20, 1962.

A fuel cartridge is described which consists of a tubular sleeve of material having low neutron absorption, a sheathed element of fissile or fertile material, and a member connected to the sleeve to support the element within the sleeve. The sheath is provided with an even number of parallel longitudinal series of cooling fins obliquely oriented in relation to the axis of the element. Each series of fins is separated from the adjacent series by a longitudinal groove. The fins of each series are oppositely directed to those of the two adjacent series so as to form herringbone pat-

terns. The element is centered in the sleeve by at least three longitudinal blades of rectangular shape. Each blade is radially disposed in one out of two of the longitudinal grooves and comprises means to prevent it from slipping in relation to the inside wall of the sleeve. The means preferably consist of teeth mounted on the blade which engage radially in recesses in the sleeve. In order to reduce the neutron absorption power of the blades they may be provided with openings in their surface to an extent compatible with their mechanical strength. (NPO)

37815 NUCLEAR FUEL CARTRIDGE. (to C. A. Parsons and Co., Ltd.). French Patent 1,180,325. Filed July 30, 1957.

A fuel cartridge is described which consists of a cylindrical sheathed fuel element housed in a cylindrical graphite casing which has an extended surface, e.g., a surface provided on its outside with helical cooling fins. The axial length of the fuel element is smaller than the axial length of the casing. Preferably the passages between the fins are interrupted by longitudinal baffles extending for the length of the casing. (NPO)

37816 TUBULAR WALL FOR A NUCLEAR REACTOR CHANNEL. (to Siemens Schuckertwerke Aktiengesellschaft). French Patent 1,433,828. Filed May 10, 1965.

A tube intended to form the wall of a nuclear reactor channel is described which consists of a material having a low mechanical resistance, e.g., graphite, BeO, SiO_2 or similar ceramic materials The tube is provided with metallic reinforcements, e.g., longitudinal or helical wires or wire-gauze, preferably having a coefficient of expansion which equals the coefficient of expansion of the material of which the tube consists. (NPO)

37817 NUCLEAR FUEL ELEMENT. (to EURATOM). French Patent 1,498,187. Filed Nov. 3, 1966.

A fuel element is described which consists of a sheathed fuel rod disposed in a central channel of a prismatic body which consists of a moderating material. The body is provided on its outside with longitudinal ribs for engagement in corresponding longitudinal grooves of adjacent bodies. Preferably the body has a hexagonal cross-section, each of its lateral faces being provided with a longitudinal groove having a trapeziform cross-section, the base of which coincides with the side of the hexagon. The three other sides of the trapezium have a length which equals a quarter of the length of the side of the hexagon. The wall of the central channel of the moderator body is provided with a helical groove having a large pitch and a square cross-section. (NPO)

37818 CARBIDE NUCLEAR FUEL. (to Westinghouse Electric Corp.). French Patent 1,493,842. Filed Sept. 7, 1966.

A nuclear fuel is described which consists of 4.56 to 4.85 wt % of C and 0.40 to 5.17 wt % of Cr, the remainder being U and/or Pu. Preferably the Cr-content amounts to about 3.4 wt % and the C-content amounts to 4.75 wt %. In case the remainder consists of U and Pu, the Pu comprises 15 to 30% of the combined weight of U and Pu. (NPO)

37819 PRISMATIC FUEL ELEMENTS FOR NUCLEAR REACTORS AND MEANS FOR GUIDING THEM ONE AGAINST THE OTHER. (to Commissariat a l'Energie Atomique). French Patent 1,309,370. Filed Oct. 4, 1961.

Prismatic fuel elements are described which are assembled in juxtaposition in the reactor. The lateral faces of adjacent elements are in contact with each other. In order to facilitate the introduction of an element into the reactor between others which are already present, the longitudinal edges of the prisms are chamfered at their upper ends in such a way as to form triangles, the apexes being situated on these edges and the ends of the bases touching each other in a cross-section of the element. Preferably the lower end of the element is lengthened by a directing-piece consisting of a truncated pyramid which bears a longitudinal bar. (NPO)

37820 SUPPORT FOR NUCLEAR REACTOR FUEL ELEMENTS. (to Gesellschaft fuer Kernforschung). French Patent 1,432,836. Filed Feb. 25, 1965.

The support comprises a horizontal bearingplate from which several fuel elements are suspended parallel to each other, only a short distance separating the elements. The plate is provided with a preferably square central hole from which lateral narrow slots are extending in several directions. The elements are introduced into the support by lowering them into the central hole, after which they are moved sidewards along the slots to their final positions. Preferably a second bearingplate of the same configuration is mounted in alignment with the first in order to put the elements in perfect parallellism with respect to the axis of the coolant channel of the reactor. The elements are provided at their upper ends with a supporting-bar, which is profiled in accordance with the dimensions of the slots. (NPO)

37821 FUEL ELEMENT FOR NUCLEAR REACTOR AND METHOD OF ASSEMBLING SUCH ELEMENTS. (to Commissariat a l'Energie Atomique). French Patent 1,380,645. Filed Oct. 18, 1963.

A fuel plate for a nuclear reactor is described comprising a fuel material enclosed in a plate-shaped protective sheath. The ends of plate contain no fuel. The plate ends have substantially the same external dimensions as the remainder of the sheath and are deformed away from the main plane of the sheath and machined to form parts for engagement with other similarly shaped sheath plates. Multiple plates can therefore be assembled together in a stack. The plate ends may be deformed by bending in the same direction so as to make a U-shape or in opposite directions so as to make an S-shape. Assembling is carried out by placing a plurality of fuel plates together so that their machined ends engage one with another a gap between adjacent plates. The adjacent ends are welded together by electron bombardment with the direction of the electron beam being parallel to the major plane of the plates. (NPO)

37822 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,303,334. Filed Oct. 10, 1961.

The cylindrical container of the element is provided on its outside with helical cooling fins and with flow-splitting longitudinal baffles which intersect the channels between the fins and extend radially to a position close to the wall of the coolant channel. In order to stabilize the element in the coolant flow the baffles are winged at their extremities in such a way as to have an L- or a T-shaped cross-section, the wings being of unequal length in the longitudinal direction of the element. (NPO)

37823 FUEL ELEMENT FOR NUCLEAR REACTOR. (to General Electric Co., Ltd.). French Patent 1,291,822. Filed Apr. 12, 1961.

A fuel element is described which has an elongate form and which has its ends equipped with members that make it possible to stack a series of elements in the coolant channel of the reactor. In order to stabilize the element against vibration it is provided at one end with radially extensible members (e.g., levers, springs or other elastic means) which are in their retracted position when the element is introduced into or taken out of the coolant channel. When the element is in operative position in the channel the members are automatically moved into their extended position in which they contact the wall of the channel, thereby preventing transverse movement of the element. Various construction of the members are given. (NPO) (UK)

37824 FUEL ELEMENTS FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,283,426. Filed Feb. 22, 1961.

A fuel element of elongate form is described which has its ends equipped with members that make it possible to be stacked in a series. In order to stabilize the element against vibration it is provided at least at one end with radially extensible support members. In the extended position the members contact the wall of the coolant channel, thereby preventing transversal movement of the element. The members are automatically moved from the retracted into the extended position either by the weight of the fuel element resting on it or by the axial movement between adjacent elements bringing the elements into engagement with one another. Various constructions are given. (NPO) (UK)

37825 DEVICE FOR EXTRACTING GASEOUS FISSION PRODUCTS FROM A NUCLEAR FUEL ASSEMBLY. (to Commissariat a l'Energie Atomique). French Patent 1,464,796. Filed Nov. 23, 1965.

A device is described for extracting gaseous fission products from an assembly of fuel elements wherein fissile or fertile material is enclosed in a sheath which is impermeable to gases and is provided with internal narrow channels for passing a coolant, e.g., liquid Na, through the element. The sheath is closed by end-plates and a porous plug is inserted between the fissile or fertile material and the lower end-plate. The plug is provided with a cavity which is connected by a drain-pipe to a common gas collecting system. The collecting system is provided with an apparatus for the decontamination of the fission gases before they are discharged into the atmosphere and with a source of a pressurized inert gas, e.g., Ar, intended to rinse the elements before replacing the assembly. The collecting system can be introduced into each element by way of the drain-pipe. The drain-pipes are made up of two hermetically contacting parts which are disconnected from one another before the replacement of the assembly. (NPO)

37826 SPACING DEVICE FOR NUCLEAR FUEL ASSEMBLY. (to Gesellschaft fuer Kernforschung mbH. French Patent 1,425,091. Filed Feb. 22, 1965.

A device is described for spacing apart a plurality of parallel elongate fuel elements. The spacers consist of a plurality of relatively short members having a circular cross-section and allowing the passage of a coolant flow. The spacers are located in longitudinal rows between adjacent elements, the members of adjacent rows preferably being disposed in longitudinally spaced transversal planes across the assembly. In order to facilitate the manufacture of the device and the arrangement of the spacer members, the members of each row are interconnected by elongate extension, e.g., bars or strips, of small cross-section. If the spacer members are hollow bodies they may be interconnected by tubes. Different forms of spacer members and extensions are shown in the figures of an accompanying drawing. (NPO)

37827 FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,407,393. Aug. 20, 1964.

The annular container of the element is provided on its outside with cooling fins, which are arranged in a herringbone pattern, the axis of each herringbone running parallel to the central axis of the element. The container is conveniently manufactured by providing two tubular bodies with helical fins, one of them in left-handed and the other in right-handed inclination, dividing the bodies lengthwise into an even number of longitudinal sectorial parts, and joining these parts (e.g., by soldering with an electronic beam) into a new tubular body, the container, with the adjacent parts being wound in opposite directions. Longitudinal straight fins may be provided between the sectors to give anti-bending strength to the structure. (NPO)

37828 FUEL ELEMENTS FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,430,547. Filed Mar. 11, 1965.

In order to improve the heat transfer from the element to the coolant, the wall of the container, which is composed of Mg or Mg-alloy, is covered on its outside by a dull black coating. The element is immersed for about 10 min. at 15°C in an aqueous solution containing about 10% $Na_2Cr_2O_7 \cdot 2H_2O$, 5% $MnSO_4 \cdot 4H_2O$, 5% $MgSO_4 \cdot 7H_2O$ and 0.01 to 0.03% $AgNO_3$. The pH is maintained at 2 to 5 by adding H_2SO_4. The treatment may be shortened by raising the temperature to 55°C at the utmost. After taking the element out of the bath it is washed with water and dried in an air current at 80°C. (NPO)

37829 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to Nuclear Power Group). French Patent 1,366,880. Filed June 4, 1963.

The cross-section of the element, instead of being circular in the conventional way, has a flattened (e.g., rectangular or elliptical) shape. The flattened surfaces of the container are provided with cooling fins, which are arranged in a helical or a herringbone pattern. In this way a violent turbulence is brought about in the flow of the coolant on both sides of the element between its flattened surfaces and the cylindrical wall of the coolant channel, resulting in an improved heat exchange. (NPO)

37830 FUEL ELEMENT FOR NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,420,289. Filed Jan. 12, 1965.

A cylindrical fuel element is described. Fitted on its outside are cooling fins arranged in a helical or herringbone pattern. In order to prevent deformation of the fins by the forces exerted by the flowing coolant the fins are mounted with an inclination to the normal on the cylindrical surface in a direction opposite to the coolant flow. Preferably this inclination is of the same order as the inclination of the fins with respect to the longitudinal axis of the element. (NPO)

37831 IMPROVEMENT IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to C. A. Parsons and Co., Ltd.). French Patent 1,381,807. Filed Feb. 3, 1964.

Instead of being cylindrical the element is prismatic with a lozenge-shaped cross-section. The four lateral faces are provided in pairs by cooling fins in such a manner as to form a chevron on each side of the element. Longitudinal channels in the chevrons are situated at the obtuse-angled edges of the prism. The coolant, flowing from these channels through those between the fins to the acute-angled edges of the prism, follows a path corresponding with decreasing thickness of the fuel, i.e., diminishing heat development. In this way the heat exchange is improved. Other cross-sections of the element (e.g., elliptical), based on the same principle, may be used. (NPO)

37832 ANNULAR FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,440,696. Filed Mar. 26, 1965.

An annular fuel element is described which has coolant flowing along its outer wall and through the central channel. The container is fitted on its outside with cooling fins arranged in a conventional pattern. In order to improve the heat transfer from the element to the coolant the wall of the central channel is also provided with cooling fins, arranged in a herringbone pattern, with a height not exceeding 15% of the diameter of the channel and a maximum inclination of 20° with respect to the axis of the element. (NPO)

37833 IMPROVEMENT IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,369,596. Filed July 19, 1963.

In order to restrain any tendency for coolant flow-induced vibration of a fuel element it is provided at its lower end with at least three flap-like lateral-support members, pivotally mounted so as to be displaced radially outwards by the upwards flowing coolant to contact the wall of the coolant channel. (NPO)

37834 SUPPORTING DEVICE FOR NUCLEAR FUEL ELEMENTS. (to Commissariat a l'Energie Atomique). French Patent 1,408,831. Filed July 7, 1964.

A device is described for supporting a fuel element in vertical position inside an annular metal jacket. The element consists of an outer can provided with longitudinal sets of cooling fins being separated by longitudinally extending grooves and preferably being arranged in a herringbone pattern. The device comprises a set of metal centering members in the form of flat plates fixed to the jacket along generating lines of its inner surface, each plate having at its lower end a flange engaging in a slot formed in a cylindrical end piece on which the lower end of the element rests. Each plate enters one of the longitudinal grooves. Preferably each flat plate is provided at its lower part with an extension enabling two successive jackets to be relatively centered when superimposed in a reactor duct. The fixing of each plate to the jacket may be effected by welding or bolting and may be carried out either solely in the upper part of the jacket or at points suitably distributed over the entire height of the plate. (NPO)

37835 SUPPORT FOR NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,405,390. Filed May 28, 1964.

A star-shaped member for supporting a fuel element in a cylindrical casing is described. The element rests on the central part of the member and the lateral extensions contact the casing. The support member is made of sheet metal, the lateral extension being bent in such a way that their planes are parallel to the axis of the casing and their flat extremities are in free sliding engagement with longitudinal grooves provided in the inner wall of the casing. The grooves are interconnected by transversal annular groove. By rotation of the support member the extremities enter the annular groove thereby immobilizing the member in longitudinal direction. The fuel element is then lowered into the casing until it rests on the support member and it is centered in the casing by means of longitudinal laterally extending blades being in engagement with the longitudinal grooves. (NPO)

37836 FUEL ELEMENT POSITIONER. Oak, Cecil R. (to United States Atomic Energy Commission). U. S. Patent 3,448,872. June 10, 1969.

An apparatus is described for orienting a ribbed fuel element being inserted in a nuclear reactor. Internally grooved rotators rotate a fuel element having at each end three ribs spaced 90° from one another so that the fuel element enters the reactor with its ribs at the positions of 9 o'clock, 12 o'clock, and 3 o'clock. (AEC)

37837 IMPROVEMENT IN NUCLEAR REACTOR FUEL ELEMENTS. (to Atomic Energy of Canada Ltd.). French Patent 1,418,010. Filed Oct. 8, 1963.

A method is described for improving the thermal conductivity of a previously shaped, sintered and densified mass, consisting of UO_2, PuO_2, ThO_2 or mixtures thereof, by reducing the oxygen to fuel metal ratio to a value below 2.0 but above 1.90. The method comprises heat treating the dioxide material at a temperature above 1500°C either in an O_2-free gaseous medium or in vacuo or in the presence of a solid getter, e.g., Ta, Mo, W and mixtures thereof or graphite, which is not dispersed within the material, until a dioxide mass, in which at least part of the oxide is hypostoichiometric, results. In a modification the dioxide is introduced in a fuel element having a core or end-plates consisting of a getter metal and said reduction is effected in situ operating the reactor at a temperature above 1500°C. (NPO)

37838 FUEL ELEMENT FOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,378,204. Filed Sept. 25, 1963.

A sheathed fuel element is described which consists of a sheath surrounded by a cylindrical casing connected to the sheath by centering means. The whole assembly of sheath, centering means and casing is formed in one piece of metal by extrusion. The metal preferably consists of an Al–Zr alloy containing at least 0.45% of Zr. The sheath may be provided with longitudinal cooling fins or fins having a chevron pattern. The fins preferably are formed during the extrusion of the whole assembly. (NPO)

37839 METHOD OF PROCESSING COATED NUCLEAR FUELS. (to Kernforschungsanlage Juelich des Landes Nordrein-Westfalen e.v.). French Patent 1,483,117. Filed June 7, 1966.

A method of processing a coated nuclear fuel for a high temperature reactor is described. The method comprises reacting the fuel at a temperature between 350 and 600°C, preferably 450°C, with a hyperoxide and/or peroxide melt which has been mixed with a flux. The proportion of hyperoxide and/or peroxide in the melt is between 25 and 70 wt.%. Preferably KO_2, Na_2O_2 or BaO_2 are employed, using NaOH or Na_2CO_3 as a flux. (NPO)

37840 SUPPORT JACKET FOR NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,403,060. Filed May 6, 1964.

A support jacket for a fuel element is described which consists of a cylindrical casing of a material having low neutron absorption, e.g., a Zr-alloy, longitudinal members for centering the element fixed to the internal surface of the casing, a star-shaped support member at the bottom of the casing comprising a central cylindrical part on which the element rests, and a number of circumferentially equi-spaced radial extensions. The extremities of the extensions are fastened by a bayonet-catch to the casing, and a guide-ring at the top of the casing formed by a metallic strip of circular shape is provided with short outward bent portions which are riveted to the wall of the casing. The upper and lower edges of the casing are provided with a male and a female conical chamber enabling a plurality of jackets to be stacked to a column in a vertical coolant channel of a nuclear reactor. (NPO)

37841 NUCLEAR FUEL ELEMENT. (to Commissariat a l'Energie Atomique). French Patent 1,344,930. Filed Aug. 20, 1962.

A fuel element is described which consists of a canned cartridge of fissile or fertile material disposed at the center of a jacket consisting of a material having low neutron absorption and maintained by means of longitudinal centering partitions extruded integrally with the can of the cartridge. The longitudinal edges of the partitions are recessed in toothed form to enable the cartridge to be screwed into continuous helical grooves in the inside surface of the jacket. A substantially constant radial clearance is provided between the teeth and the base of the helical grooves to permit free differential expansion of the cartridge and of the jacket. Preferably longitudinal clearance is provided between the teeth and the sides of the grooves which is variable along the whole cartridge from a minimum value in the upper part of the latter to a maximum value in its lower part. (NPO)

37842 SPACING DEVICE FOR NUCLEAR FUEL ASSEMBLY. (to Gesellschaft fuer Kernforschung mbH). French Patent 1,406,709. Filed June 27, 1964.

A device is described for spacing apart a plurality of parallel elongate nuclear fuel rods. The spacers comprise a heat resistant grid provided with apertures for passing a coolant through the assembly and other apertures encircling the fuel rods. Thus far the rods have been mounted in free sliding engagement with the apertures allowing for movement in longitudinal direction. The rods described are rigidly fixed to the grid, the latter being made of a material which is resilient in the axial direction of the assembly, e.g., a number of superimposed metallic lamellae. If the grid is to be disposed in a relatively cool part of the reactor it may be composed of an elastic plastic. Preferably the grid is not connected to the casing of the assembly or to the wall of the reactor channel thus allowing the unit of fuel rods to move as a whole in longitudinal direction. (NPO)

37843 FUEL ELEMENT FOR NUCLEAR REACTORS AND METHOD FOR ITS MANUFACTURE. (to Deutsche Akademie der Wissenschaften). French Patent 1,444,002. Apr. 28, 1965.

A container, having a cross-section of a simple (e.g., annular or rectangular) geometrical shape, is filled with fuel in powder form. Then the wall of the container is pushed inward along several longitudinal lines in order to impart a star-shaped cross section to the element. In this manner the distance between the center of the fuel and the cooled wall of the container is diminished, which results in an improved heat exchange. (NPO)

37844 IMPROVEMENT IN THE COOLING SYSTEM OF A NUCLEAR FUEL ASSEMBLY. (to Licentia Patent-Verwaltungs-GmbH). French Patent 1,494,754. Filed May 22, 1966.

A fuel assembly is described for use in a boiling-water-cooled nuclear reactor. The assembly consists of a plurality of parallel fuel rods and a plurality of elongate spiral members running the length of the assembly, each member surrounding a fuel rod or being interposed between adjacent rods. The members provide turbulence in the coolant flow. The improvement consists in the splitting up of the spiral members into longitudinally spaced sections so as to reduce the quantity of structural material introduced into the reactor while maintaining sufficient turbulence in the coolant flow between the sections. Preferably the sections are interconnected by spring strips or wide-meshed wire-gauze and are arranged in groups situated in transversal planes extending across the assembly. (NPO)

37845 NUCLEAR REACTOR CONTAINMENT SYSTEM FOR METROPOLITAN SITES. Pitt, William A.; Lemon, R. B. (to United States Atomic Energy Commission). U. S. Patent 3,454,466. July 8, 1969.

A concrete structure is described having three compartments used to contain a nuclear reactor and its primary coolant system. The first compartment, a dry well, is centrally located and completely encloses the pressure vessel. A second compartment, filled with a liquid, is at a hydrostatic level above the first compartment. The third compartment, also filled with a liquid, is at a hydrostatic level below the first compartment. A first conduit communicates the first compartment with the third compartment for slow leaks. A second conduit, sealed with a rupture disc, communicates the first compartment with the second compartment upon rupture of the primary coolant system. A third conduit, sealed with a rupture disc, communicates the pressure vessel with the second compartment upon a large overpressure transient within the pressure vessel. Both hydrostatic compartments are vented to a common gas volume formed by an outer containment structure or reactor building. (AEC)

GENERAL

37846 (AEC-tr-6869/7) UKRAINIAN PHYSICS JOURNAL. Translation of Ukr. Fiz. Zh., 12: No. 7, 1059-1222(July 1967). 167p. (TT-67-51421/7; IPST-Cat.-5067). Dep. CFSTI.

Seven articles from the original Ukrainian appeared in NSA Vol. 21, Abstract Nos. 42280, 42400, 42453, 42687, 43834, 44109, and 44110. Separate abstracts of two Brief Notes from this translation have been prepared. (L.M.T.)

For abstracts of individual papers see: 36786 and 36787.

37847 (BNL-13480) USE OF SEALS AS A SAFEGUARDS TOOL. Sastre, Cesar (Brookhaven National Lab., Upton, N. Y.). Mar. 6, 1969. 19p. Dep. CFSTI.

The security seal concept, functions and limitations of sealing systems, use of seals, and a comparison of seals with other security devices are presented. Also, types of security seals which are commercially available are described. (W.H.K.)

37848 (COO-505-15) CHEMICAL EQUILIBRIA AT HIGH TEMPERATURES AND THE MECHANISM OF VAPORIZATION OF COMPOUNDS. Final Report. Seifert, Ralph L. (Indiana Univ., Bloomington. Dept. of Chemistry). July 7, 1969. Contract AT(11-1)-505. 29p. Dep. CFSTI.

Research progress is reported on: determination of the decomposition pressure of NiO by the Knudsen effusion method; feasibility study of a recoil momentum technique to identify molecules evaporating from a surface; and determination of the thermodynamic formation constants of molten metal halides by the electronic commutator method. (M.C.G.)

37849 (CTC-14) COMMENTS ON THE DISTRIBUTION OF INDICES OF DIVERSITY. Shenton, L. R.; Bowman, K. O.; Hutcheson, K. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). July 1, 1969. Contract W-7405-eng-26. 57p. Dep. CFSTI.

Several measures of diversity in populations (and samples) have been used by ecologists and information theoreticians. For example, ecologists have used Shannon's information statistic $h_1 = -\Sigma\, p_i \ln p_i$, Simpson's distance measure $h_{2i} = \Sigma\, p_i^2$ (or its root), and Brillouin's combinatorial type measure $h_0 = n^{-1} \ln n!/n_1! \ldots n_k!$. Distributional properties of these are studied from three points of view; (a) the exact distribution is found by sample configuration enumeration, (b) approximate distributional properties are found through Monte-Carlo simulations, (c) asymptotic moments are developed and their uses in assessing departures from normality considered. It is brought out that no one method is adequate for the parameter space in general, and that asymptotic moment developments are generally markedly unstable. However, the distribution of h_1 is remarkably close to normal when the category probabilities follow MacArthur's model. The study illustrates methods of gaining insight into some of the complex distributional problems associated with multinomial structures, many of which defy neat mathematical formulation. (auth)

37850 (IS-1717) CONSTRUCTION, CALIBRATION, AND OPERATION OF A VIBRATING-SAMPLE MAGNETOMETER. Miller, Albert E. (Ames Lab., Iowa). Jan. 1969. Contract W-7405-eng-82. 72p. Dep. CFSTI.

A vibrating-sample magnetometer of the Foner type, capable of measuring magnetic moments in the 200 emu to 10^{-4} emu range from 4.2 to 300K, was constructed. The details of the construction are discussed and many figures are included that illustrate the electronic and mechanical systems used. Three different techniques used to calibrate the instrument, are discussed and compared. The general operating procedures employed in the use of the instrument are also presented. (auth)

37851 (LA-4132) THE DIRECT SOLUTION OF THE DISCRETE POISSON EQUATION ON A RECTANGLE. Dorr, Fred W. (Los Alamos Scientific Lab., N. Mex.). Feb. 15, 1969. Contract W-7405-eng-36. 13p. Dep. CFSTI.

A survey of direct methods for solving finite difference analogs of the Poisson equation on a rectangle is presented. These methods can be considerably faster than iterative methods. (53 references) (auth)

37852 (LA-4145) INTERNAL BLAST LOADING OF SCALE-MODEL EXPLOSIVE-PROCESSING BAYS. Anderson, C. A. (Los Alamos Scientific Lab., N. Mex.). Mar. 26, 1969. Contract W-7405-eng-36. 26p. Dep. CFSTI.

A study of the protective capability of high-explosive-processing buildings subjected to internal blast loading is summarized. One-eighth-scale reinforced concrete models of the facility were tested against blast from a wide range of scaled explosive-charge weights. Shock overpressures, strains, and deflections were measured at critical points of the models. The structural response of the models is compared with calculated dynamic response based on elastic and plastic material behavior, and spallation and excessive deflection of the models are compared with conventional explosive-effects data. From the test results, guide lines were established for the protection of personnel in typical explosive-processing buildings. (auth)

37853 (MLM-1627) DERIVATION OF MODIFIED WEBER-SCHMIDT EQUATION FOR THERMAL TRANSPIRATION. McConville, G. T. (Mound Lab., Miamisburg, Ohio). June 1, 1969. Contract AT-33-1-GEN-53. 18p. Dep. CFSTI.

A detailed derivation of a modified version of a Weber-Schmidt equation is given in which the dependence on momentum and thermal accomodation is explicitly given. The final form of the integral equation allows numerical solutions to be obtained from an iterative process. (auth)

37854 (NYO-1480-115) DECAY OF SOLUTIONS OF SYSTEMS OF HYPERBOLIC CONSERVATION LAWS. Glimm, James; Lax, Peter D. (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). Apr. 1969. 112p. Dep. CFSTI.

We are dealing with a system of two partial differential equations of the form $u_t + f_x = 0$, and $v_t + g_x = 0$, where f and g are functions of u and v subject to the following conditions: the system is hyperbolic, the system is genuinely nonlinear, and the interaction of two shocks of the same family always produces a shock of the same family plus a rarefaction wave of the opposite family. Denote by ϵ the oscillation of the initial data. The initial data need not have bounded total variation. Results are as follows: For epsilon small enough the solution of the initial value problem exists for all positive time. If the initial data are periodic the solution decays like 1/t. The proofs are based on inequalities which take into account the interaction of shock waves and rarefaction waves of the same family. The estimates prove that such interactions must occur and that when they do occur they lead to decay in the solution. The inequalities presented can also be used to prove if the initial data are constant outside of a compact interval, the solution decays like $1/(t)^{\frac{1}{2}}$. (auth)

37855 (NYO-1480-118) BALM: AN EXTENDABLE LIST-PROCESSING LANGUAGE. Harrison, Malcolm G. (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). June 1969. Contract AT(30-1)-1480. 15p. Dep. CFSTI.

An extendable list-processing system currently implemented on the CDC 6600 which includes the facilities provided by LISP 1.5, and permits the programmer to write in an Algol-like language is described. Additional data-types include vectors, strings, and entry-points. The language can be extended by adding new operators, and by specifying how expressions involving them should be translated into an intermediate language. (auth)

37856 (ORNL-4310) MODELS OF SEASONAL PRIMARY PRODUCTIVITY IN EASTERN TENNESSEE FESTUCA AND ANDROPOGON ECOSYSTEMS. Kelly, J. M.; Opstrup, P. A.; Olson, J. S.; Auerbach, S. I.; Van Dyne, G. M. (Oak Ridge National Lab., Tenn.). June 1969. Contract W-7405-eng-26. 305p. Dep. CFSTI.

Thesis. Submitted by J. M. Kelly and P. A. Opstrup to Univ. of Tennessee, Knoxville.

Three purposes of study were: to test various sampling and mathematical techniques in the analysis of grasslands typical of eastern Tennessee, to explore the feasibility of increasing efficiency in future investigation, and to use computer models for theoretical estimation of gross and net production and for mathematical description of transfer coefficients or functions in grasslands. Widely planted Kentucky-31 tall fescue (Festuca elatior var. arundinacea Schreb.) and the normal native old-field (or pasture) invader called broomsedge or sagegrass (Andropogon virginicus L.) dominated the areas studied on Clinch River terrace soils in Oak Ridge. Both communities had nearly equal annual net primary production (root plus top) but phenological cycles of dominant and minor species were quite different. Productivity estimates would have been biased on the low side without careful repeated sampling by species and/or allowance for losses of live material that occur simultaneously with growth. Present agreement between empirically and theoretically derived estimates suggests that results of both are nearly valid and complementary, but some improvements for future work are suggested. At each sample date above-ground herbage in forty 1 m^2 plots was collected and a 0.25 m^2 sub-sample was sorted, dried and weighed. Twenty root core samples were taken from within the plots. Supplementary data on

herbage mass were derived from an additional 100 unclipped plots that were measured with a capacitance meter; proportions of standing dead were visually estimated; a rank was assigned to the species according to its weight. Computer programs combining these data gave accurate estimates of the vegetation composition on a dry weight basis with a minimum of cutting and hand separating of samples. The ratio of "ranked only" plots to those clipped could be as high as 50 to 300 : 1 to allow for coverage of a much larger area without greatly disrupting the vegetation. Negligible differences between methods were found for species herbage biomass estimates when the vegetation was uniform, but when great variation was present the rapid-sampling method was better able to represent the irregularly distributed species. The estimation of total yield by the capacitance meter method did not detect significant differences ($P \leq 0.1$) compared with clipping for peak biomass values of the two communities. Estimated total yield values were 678 g/m^2 and 1012 g/m^2, respectively, for the Festuca and Andropogon communities, as compared to the clipped values of 672 g/m^2 and 958 g/m^2 (including standing dead or attached litter as well as live material). Positive changes in live biomass during phenologically appropriate periods were summed, giving 1001 and 892 g/m^2 as the first empirical estimates of cumulative annual oven dry organic production for Festuca and Andropogon communities. (Revisions adjusted slightly for possible sampling bias are given below.) Trends in standing (attached) dead above-ground vegetation differ: the maximum for Festuca (408 g/m^2) came in early summer, near time of flowering, while that for Andropogon (806 g/m^2) occurred just after frost killed most of the live tops. Detached litter on the ground remained low and comparatively constant: near 114 and 181 g/m^2, respectively. High apparent daily mean production rates approximated by biomass changes varied seasonally: 1.21 to 3.29 g/m^2 · day (for intervals March 1 to April 27 and April 27 to May 15) for the Festuca community, and 1.05 to 3.34 g/m^2 · day (March 10 to June 7 and June 7 to August 7) for the more mixed Andropogon community. Declining biomass change for later dates presumably reflected increased losses as the mass of live and dead compartments increased, as well as declining carbon assimilation rates. A 7-compartment model was designed in order to simulate plausible redistribution of biomass through major parts of the system. Transfer coefficients of the final model were constant or seasonally varying and were derived from observed rates of change, plus our ancillary studies or approximations from the literature. The seasonally varying coefficients were expressed as periodic or exponential functions of arbitrary inputs that were independent of the system's state variables, and seem related to biological cycles or environmental inputs. The data were fit well by successive approximations, but problems of predicting results with the model over several years were not treated with data for one year (1967). Due to an unusually wet July, an expected summer decline in growth of the cool-season Festuca did not occur; both it and the warm-season Andropogon may have been more productive than for years of average moisture, but depth of root penetration might have been less because water tables remained high. From the model, gross production was estimated to be at least 1145 g/m^2/yr for the Andropogon and 1220 g/m^2/yr for the Festuca communities (probably higher). The net primary production of these two communities (gross production minus plant respiration) was estimated within upper and lower bounds that were derived according to whether the turnover in the root compartment (assumed near 25% per year) was due strictly to respiration or due to death of roots; realistic values should lie within the range given below unless this assumed root loss was too low. The net primary production in the Festuca community was thus estimated to be in the plausible range from 921 g/m^2 to 1115 g/m^2 as compared with adjusted clipping estimates of 992 g/m^2. For the Andropogon community the range was estimated to be from 853 g/m^2 to 1060 g/m^2 compared with 892 g/m^2 calculated from the clipped data. This study provided improved results, or suggested needs for further refinements of technique, in several aspects of grassland herbage dynamics: minimal limits on net production from biomass change in Festuca and Andropogon old-field communities appeared to be closer estimates of total community net production than most values found in the literature because (a) the sampling was sufficiently frequent to be close to peak mass for each significant taxon, (b) subsamples were separated into living and dead tops, (c) the detached (fallen) litter, and rates of input and decomposition for it were measured in a supporting study, and (d) root mass changes (ash-free) from 20 cores per collection give a means to obtain indirect estimates of mass translocation to and from root storage. Estimates of some transfer rates still need to be quantified, especially losses due to animal consumption and respiration, translocation of soluble carbohydrates, and better approximations for turnover from roots. Estimated rates of input to and loss from standing (attached) dead tops for the current year seem realistic, but could be refined if separate estimates for the previous year's dead tops could be made. (Many studies neglect or underestimate these transfers for both young and old dead material.) Satisfactory methods of identifying age classes and transfers for such material need further attention. Input and decomposition rates for detached litter appear to be balanced so a steady-state was approximated surprisingly well; yet income and loss rates must both vary seasonally, and hence seem to be fairly well in phase with one another. For many ecosystems we should not expect such convenient balances and phasing. Total live community biomass is till increasing (mostly as roots) in the young Festuca stand, while this total appears more nearly stabilized in the older, more mixed stand where Andropogon contributes only about half the above-ground production. Longer-term measurements are needed to relate slow trends to successional change (in which Festuca would normally be diluted by Andropogon, Rubus and more woody communities). Root biomass (ash free g/m^2) in the top 20 cm of soil was much greater, and changed more seasonally, than in deeper layers: from 202 to 659 in November under Festuca, and from 377 to 659 (also) in late October under Andropogon. For 20-60 cm soil layers, roots increased from about 76 to 214 g/m^2 in July under Festuca and from 69 to 166 in August under Andropogon in 7.5 cm diameter hydraulic cores. Coefficients of variation were higher for the latter than for the 20 cm diameter cores, but the latter were practical only for 0.20 cm depths. (auth)

37857 (PRNC-131) PUERTO RICO NUCLEAR CENTER ANNUAL REPORT, 1968. (Puerto Rico Nuclear Center Mayaguez). Contract AT(40-1)-1833. 178p. Dep. CFSTI.

Developments at the Puerto Rico Nuclear Center, which engages in training and research in the peaceful use of nuclear energy, are summarized. Developments in nuclear science, nuclear engineering, physical sciences, clinical radioisotope applications, radiotherapy and cancer research, agricultural bio-sciences, medical sciences and radiobiology, research reactors, health physics, and radioecology are outlined. Also, papers, publications, and seminars are listed. (W.H.K.)

37858 (RCN-107) STRZ-2, AN ALGOL PROGRAM FOR THE CALCULATION OF THE STEADY-STATE TEMPERATURE DISTRIBUTION IN R-Z GEOMETRY WITH TEMPERATURE DEPENDENT HEAT CONDUCTION COEFFICIENTS AND RADIATION IN NARROW GAPS. Struch, H. P. (Reactor Centrum Nederland, Petten). May 1969. 70p. Dep.

STRZ-2 is an ALGOL program for the calculation of the steady-state, rotationally symmetric temperature field in an inhomogeneous cylindrical body, in which heat production, radiation in narrow gaps, and heat conduction with temperature and direction dependent conduction coefficients may occur. At most 2000 mesh-points are allowed. STRZ-2 is a revised version of the original FORTRAN program STRZ. A new polynomial inner iteration procedure is applied, which reduces the number of inners to be executed by approximately a factor of 2. (auth)

37859 (RFP-1292) COMPUTER PROGRAM FOR INDEXING CRYSTALS FROM THEIR X-RAY POWDER PATTERNS. Heiple, Clinton R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Mar. 28, 1969. Contract AT(29-1)-1106. 93p. Dep. CFSTI.

INDEX is a computer program written in Fortran IV-G which indexes materials on the basis of their X-ray powder patterns. The program can be run on the IBM 360/40. Crystals belonging to the cubic, hexagonal, tetragonal, and orthorhombic classes can be indexed by supplying the 2θ reflections, where θ is the Bragg angle. (auth)

37860 (RFP-1329) A REVISED FORTRAN IV PROGRAM TO CALCULATE CRYSTALLOGRAPHIC FUNCTIONS. Werkema, George J. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). May 14, 1969. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

A revision of a program written earlier (USAEC Report RFP-326, August 1963) for a small computer is presented. The availability of a computer having a medium-to-large memory permits various improvements in operating convenience to be made. The present program has been written in IBM 360 E-level FORTRAN IV. Values of the interplanar spacing "d," $\sin^2\theta$, and 2θ are calculated for the crystallographic planes hkl. Planes that are found to be systematically nonreflecting by virtue of the space group symmetry elements coded in the data are omitted from the output list. The calculated results are sorted on increasing 2θ in blocks of 2000 before listing. (auth)

37861 (SCL-DR-69-49) MESHGEN: A COMPUTER CODE FOR AUTOMATIC FINITE ELEMENT MESH GENERATION. Egeberg, J. L. (Sandia Labs., Livermore, Calif.). July 1969. Contract AT(29-1)-789. 42p. Dep. CFSTI.

MESHGEN automatically generates and plots finite element mesh data for use with finite element computer programs, and is especially oriented toward axisymmetric codes such as program ARBAS. Boundary conditions may also be prescribed prior

to the mesh generation. An option is included for punched output data for use as input for the finite element codes. MESHGEN and ARBAS will also be available in coupled form to give a single-mesh-generating finite element code. (auth)

37862 (UCRL-7322(Rev.1)) CALCULATION OF ELASTIC-PLASTIC FLOW. Wilkins, Mark L. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 24, 1969. 101p. Dep. CFSTI.

Computer programs based on the artificial viscosity method are presented for solving problems in dynamic plasticity. The programs are formulated in one-space dimension and in two-space dimensions with axial symmetry. The constitutive equations are organized so that loading and unloading paths are automatically treated. Details are presented for calculation of sliding interfaces and of opening and closing of voids. Examples ranging from quasi-static elastic-plastic flow to dynamic problems involving elastic-plastic shocks are given. (auth)

37863 (UCRL-18775) COMPUTER GENERATION OF SERIES AND RATIONAL FUNCTION SOLUTIONS TO PARTIAL DIFFERENTIAL INITIAL VALUE PROBLEMS. Gey, F. C.; Lesser, M. B. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 1969. Contract W-7405-eng-48. 34p. (CONF-690807-1). Dep. CFSTI.

From National Association of Computing Machinery Conference, San Francisco, Calif.

Series and rational function approximations provide a viable alternative to finite difference methods in the solution of partial differential initial value problems. Large scale symbolic algebra manipulation systems can be used to generate such approximations for a very general class of problems. The use of operator derivatives keeps the method from being limited to ordinary power series. The procedure is applied to the non-linear Burgers' equation $u_t + u \cdot u_x = u_{xx}$ with periodic initial condition $u(x,0) = \sin(x)$, and the results are compared to an asymptotic expansion and a finite difference solution. (auth)

37864 (UCRL-50636) MANUFACTURING ACCURACY THROUGH THE CONTROL OF THERMAL EFFECTS. McClure, Eldon R. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 30, 1969. 320p. Dep. CFSTI.

Thesis.

Power supplied to a machine tool is converted into heat resulting in thermal distortions in finished workpieces. Imperfect control of ambient temperatures causes gaging errors. The manufacturing errors are produced by non-ideal thermal environments. Methods of detection that are related to established concepts of engineering metrology are described. Thermal effects are experimentally shown to be describable as linear dynamic processes. The drift of a gage can be characterized by its response to a step input in ambient temperature, and the distortion of a machine-tool structure in response to multiple internal heat sources can be approximated by a linear lumped-parameter model whose parameters are identified by an analysis of experimental data. Two methods of reducing or eliminating thermal effects are investigated. One is automatic error compensation, a form of which is derived from the error predictor that results from the identification of the parameters in the lumped-parameter model. A simple, inexpensive error computer based on thermal analogy is demonstrated. The other method is the regulation of structural temperatures by means of fluid coolants. Errors resulting from the expansion of the workpiece and the cutting tool during the turning of cylindrical parts is investigated both analytically and experimentally. Measurable cutting parameters can be used to predict workpiece expansion to within a constant multiplier. An investigation of the difference between dry cutting and cutting with a coolant shows that the coolant typically reduces workpiece expansion and total expansion. Thermal effects are highly deterministic, above error-reduction methods can decrease thermal effects to the level of other systematic error sources, the control of thermal effects is economically significant in terms of both the cost of achieving it and the returns gained from it, and the user of manufacturing equipment should guard against thermal effects by specifying appropriate thermal stabilities. (auth)

37865 (UCRL-50646) BOMM/LRL: A SYSTEM OF PROGRAMS FOR ANALYSIS OF TIME SERIES. Stinner, Robert J.; Bailey, David S. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 17, 1969. 45p. Dep. CFSTI.

The BOMM code for spectral analysis of digitized series designed for use on the IBM 7090 computer has been modified to BOMM/LRL to run on the CDC 6600 computer using the Chippewa compiler and the FROST monitor system at Lawrence Radiation Laboratory. (The BOMM code was developed at the Institute of Geophysics and Planetary Physics at the University of California at La Jolla.) Features of BOMM/LRL include the ability to join, merge, or decimate series at will; to analyze and correct them for errors; and finally to convolve, transform, or cross-correlate as desired. Fader windows, filters, and other types of series that have desired characteristics can be generated as needed. Results can be plotted on the on-line printer or on the CRT. In the process of conversion, all tape usage (series storage, chain-link storage, etc.) was eliminated and replaced by disk storage of series. On sample problems, an improvement of 6 to 10 times faster in running time than the IBM 7090 has been achieved. (auth)

37866 (WAPD-TM-398(Add.2)) SEAL-SHELL-2: A COMPUTER PROGRAM FOR THE STRESS ANALYSIS OF A THICK SHELL OF REVOLUTION WITH AXISYMMETRIC PRESSURES, TEMPERATURES, AND DISTRIBUTED LOADS. Friedrich, C. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1969. Contract AT(11-1)-Gen-14. 25p. Dep. CFSTI.

A revised version of Seal-Shell-2 is described. The reference surface of the shell may be placed anywhere between the inside and outside surfaces, not just at the middle surface. Also, the program may be used to plot stress against segment index. The program is written in FORTRAN IV and has been used on PHILCO-2000, IBM-704, and CDC-6600. (auth)

37867 (Y-1673) SODIUM AND STRONTIUM SHOCK PRESSURE TRANSDUCERS. Huddleston, R. L.; Sladky, R. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 9, 1969. Contract W-7405-eng-26. 59p. Dep. CFSTI.

Eight shock pressure transducers which were developed and fabricated at the Oak Ridge Y-12 Plant (four with sodium metal as the pressure-sensitive grid and four with strontium metal) are described. These transducers operate on the principle that significant changes in electrical resistivity occur with changes in pressure. Final shock testing is to be performed at the Lawrence Radiation Laboratory. (auth)

37868 (Y-1674) FABRICATION OF SHOCK PRESSURE TRANSDUCERS. Huddleston, R. L.; Sladky, R. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 17, 1969. Contract W-7405-eng-26. 33p. Dep. CFSTI.

The strontium, lithium, and calcium transducers, which are the subject of this report, have distinct improvements over the strontium and sodium transducers described in an earlier companion report (Sodium and Strontium Shock Pressure Tranducers, Y-1673). Some of the principal changes from the earlier models are: (1) a very thin sensing grid is vapor deposited on the surface rather than forming a metallic grid; (2) the grid is backed by fused quartz rather than beryllium oxide-loaded epoxy; (3) the connecting pins are made of magnesium rather than copper. Other minor improvements were also made. The changes that were made were intended to improve transducer output, reduce the electrical noise level with respect to the output signal, and improve the shelf life. (auth)

37869 PLUTONIUM-DOKUMENTATION: MIT ANHANG TRANSPLUTONIUM-ELEMENTE. Mai 1969. Band 3, Heft 5. 135 Referate (Register-Nr. 1393-1675). (Plutonium-Documentation. With Appendix on Transplutonium Elements. Vol. 3, No. 5, 135 References (No. 1393-1675)). Karlsruhe, Ger., Gesellschaft fuer Kernforschung m.b.H., 1969. 130p. (In German and English).

One hundred and thirty-five references are presented under the following headings: physical properties of plutonium, its alloys, and compounds; chemistry of plutonium and its compounds, reprocessing, and isotope separation; alloys and metalloid systems with plutonium; production of plutonium by nuclear reactions; handling of plutonium; utilization of plutonium; economic problems and development programs; and history and bibliographies. (M.C.G.)